Leandro Fornias Machado de Rezende

Comportamento sedentário e desfechos na saúde de idosos: uma revisão sistemática

Dissertação apresentada à Faculdade de Medicina da Universidade de São Paulo para obtenção do título de Mestre em Ciências

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Orientadora: Profa. Dra. Olinda do Carmo Luiz

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"Lack of activity destroys the good condition of every human being while movement and methodical physical exercise save it and preserve it"

Plato

NORMALIZAÇÃO ADOTADA NESTA DISSERTAÇÃO

Esta dissertação está de acordo com as seguintes normas, em vigor no momento desta publicação: Referências formato Vancouver adaptado.

Universidade de São Paulo. Faculdade de Medicina. Divisão de Biblioteca e Documentação. *Guia de apresentação de dissertações, teses e monografias*. Elaborado por Anneliese Carneiro da Cunha, Maria Julia de A. L. Freddi, Maria F. Crestana, Marinalva de Souza Aragão, Suely Campos Cardoso, Valéria Vilhena. 3a ed. São Paulo: Divisão de Biblioteca e Documentação; 2011.

Abreviaturas dos títulos dos periódicos de acordo com *List of Journals Indexed in Index Medicus*.

SUMÁRIO

LISTA DE SIGLAS

ACSM	*American College of Sports Medicine*
AHA	*American Heart Association*
BMJ	*British Medical Journal*
CENTRAL	*Cochrane Central Register of ControlLed Trials*
CINAHL	*Cumulative Index to Nursing and Allied Health Literature*
eIFL -	*Electronic Information for Libraries*
EMBASE	*Excerpta Medica*
FAPESP	Fundação de Amparo à Pesquisa do Estado de São Paulo
GPAQ	*Global Physical Activity Questionnaire*
GRADE	*Grades of Recommendation, Assessment, Development and Evaluation*
GSHS	*Global School-Based Student Health Survey*
HBSC	*Health Behavior in School-aged Children*
HDL-c	*High Density Cholesterol*
HINARI	*Health InterNetwork Access to Research Initiative*
INASP	*International Network for the Availability of Scientific Publications*
IPAQ	*International Physical Activity Questionnaire*
IPS	*International Prevalence Study*
JAMA	*Journal of the American Medical Association*
LILLACS	Literatura Latino-Americana e do Caribe em Ciências da Saúde

LDL	*Low Density Cholesterol*
LPL	Lipase Lipoproteica
MEDLINE	*Medical Literature Analysis and Retrieval System Online*
MET	*The Metabolic Equivalent of Task*
MOOSE	*Meta-analysis Of Observational Studies in Epidemiology*
NEATs	*Non-Exercise Activity Thermogenesis*
NHANHES	*National Health and Nutrition Examination Survey*
OMS	*Organização Mundial da Saúde*
PEOD	População, Exposição, *Outcome* e Delineamento
PICO	População, Intervenção, Controle e *Outcome*
PRISMA	*Preferred Reporting Items for Systematic reviews and Meta-Analyses*
QUOROM	*QUality Of Reporting Of Meta- analyses*
RR	Risco Relativo
SBRD	*Sedentary Behavior Research Database*
SBRN	*Sedentary Behavior Research Network*
STEPS	*WHO STEPwise approach to chronic disease risk factor surveillance*
VIGITEL	Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico
WHO	*World Health Organization*

LISTA DE QUADROS

RESUMO

Rezende LFM. *Comportamento sedentário e desfechos na saúde de idosos: uma revisão sistemática* [Dissertação]. São Paulo: Faculdade de Medicina, Universidade de São Paulo; 2014.

Introdução: Idosos passam a maior parte do dia em comportamento sedentário. Apesar dessa alta exposição, o impacto do comportamento sedentário na saúde dessa população ainda não foi aprofundado. **Objetivo**: Revisar sistematicamente as evidências de associação entre o comportamento sedentário e desfechos relacionados à saúde de idosos acima de 60 anos de idade. **Métodos**: Foram revisadas as bases de dados Medline, Embase, Lillacs, *Web of Science*, SportsDiscus, PsychInfo, Cinahl e *Sedentary Behavior Research Database* por estudos observacionais publicados até o mês de maio de 2013, bem como os membros do *Sedentary Behaviour Research Network*, para identificar artigos potencialmente elegíveis. Após a inclusão, a qualidade metodológica da evidência de cada estudo foi avaliada, utilizando-se o GRADE. **Resultados**: Foram identificados 23 artigos elegíveis, dos quais apenas 2 (8%) apresentaram alta qualidade de evidência. O tempo gasto em comportamento sedentário foi relacionado a um aumento no risco de mortalidade por todas as causas. Estudos com qualidade moderada de evidências indicaram relação entre o comportamento sedentário e síndrome metabólica, circunferência da cintura e excesso de peso/obesidade. Os resultados de outros desfechos como saúde mental e câncer de rim ainda são insuficientes para conclusões definitivas. **Conclusão**: Esta revisão sistemática defende a relação entre o comportamento sedentário e aumento da mortalidade em idosos. Futuros estudos com alta qualidade metodológica serão necessários para a verificação de demais desfechos em saúde e para a criação de diretrizes e recomendações sobre comportamento sedentário de idosos.

Descritores: Literatura de revisão como assunto; Estilo de vida sedentário; Saúde do idoso; Mortaliadde; Obesidade/epidemiologia; Síndrome X metabólica/epidemiologia; Fatores de risco.

ABSTRACT

Rezende LFM. *Sedentary Behavior and Health Outcomes among Older Adults: a Systematic Review* [Dissertation]. São Paulo: Faculdade de Medicina, Universidade de São Paulo; 2014.

Background: In the last decade, sedentary behavior has emerged as a new risk factor for health. The elderly spend most of their awake time in sedentary activities. Despite this high exposure, the impact of this sedentary behavior on the health of this population has not yet been reviewed. **Purpose:** We systematically reviewed evidence for associations between sedentary behavior and multiple health outcomes in adults over 60 years of age. **Methods:** We searched the Medline, Embase, Web of Science, SportsDiscus, PsycInfo, Cinahl, LILACS, and Sedentary Research Database for observational studies published up to May 2013. Additionally, we contacted members of the Sedentary Behaviour Research Network to identify articles that were potentially eligible. After inclusion, the methodological quality of the evidence was assessed in each study. **Results:** We included 24 eligible articles in our systematic review, of which only 2 (8%) provided high-quality evidence. Greater sedentary time was related to an increased risk of all-cause mortality in the older adults. Some studies with a moderate quality of evidence indicated a relationship between sedentary behavior and metabolic syndrome, waist circumference, and overweightness/obesity. The findings for other outcomes such as mental health and renal cancer cells remain insufficient to draw conclusions. **Conclusion:** This systematic review supports the relationship between sedentary behavior and mortality in older adults. Additional studies with high methodological quality are still needed to develop informed guidelines for addressing sedentary behavior in older adults.

Descriptors: Review literature as topic; Sedentary lifestyle; Aged; Health of the elderly; Mortality; Obesity/epidemiology; Metabolic syndrome X/epidemiology; Risk factors.

APRESENTAÇÃO

Nesta Dissertação, apresento parte da literatura acadêmica estudada, aulas e produção científica que tive oportunidade de desfrutar durante os dois anos de pós-graduação.

Na sessão “Revisão da literatura” desenvolvi capítulos sobre temas que deram embasamento ao desenvolvimento desta Dissertação.

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Epidemiologia: Seminários de Epidemiologia (MPR5749-2/10); Epidemiologia Clínica (MPR5730-4/3); Estudos Epidemiológicos Transversais (MPR5720-4/2); Tipos de Estudos Epidemiológicos (MPR5728-6/2); Estudos Epidemiológicos Multicêntricos em Doenças Crônicas não Transmissíveis e Estilo de Vida (MPR5761-1/1); Epidemiologia nos Serviços de Saúde (MPR5721-5/2).

Revisão Sistemática: Estratégia de Busca de Evidências nas Bases de Dados da Área da Saúde (Cochrane do Brasil/UNIFESP).

Saúde Coletiva: Seminários de Projetos Quantitativos (MPR5747-2/3); Seminários de Projetos Qualitativos (MPR5748-2/3).

Estatística: Análise Quantitativa em Saúde (MPR5740-4/1); Análise de Estudos Epidemiológicos (MPR5729-3/4).

Outros: Oficina de Escrita Acadêmica em Inglês (MPR5755-1/2); Preparação Pedagógica PAE (Faculdade de Educação da USP - EDM5102-3/3).

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1. INTRODUÇÃO

No Brasil, em 2007, cerca de 70% das mortes foram atribuídas às doenças crônicas não transmissíveis (doenças cardiovasculares, respiratórias, diabetes, câncer, entre outras) e 10% às doenças infecciosas. Contrapondo esses dados aos de 1930, tem-se que, naquele registro, as doenças infecciosas respondiam por 46% das causas de morte (Schimidt et al., 2011; Silva-Junior, 2009). O aumento dessas doenças crônicas, dentre diversos fatores – o envelhecimento populacional, por exemplo –, está relacionado à diminuição do gasto energético oriundo da mudança no estilo de vida ocorrida especialmente após a Revolução Industrial (Booth et al., 2008). É importante ressaltar que há três principais componentes de gasto de energia em seres humanos. Em geral, em indivíduos adultos, a taxa metabólica basal corresponde a aproximadamente 60% do gasto energético; o efeito termogênico da alimentação representa aproximadamente 10%-15%, e o gasto energético decorrente de atividades físicas corresponde a aproximadamente 30% (Levine, 2002).

De acordo com Caspersen, Powell e Christenson, a atividade física pode ser definida como “qualquer movimento corporal produzido pelos músculos esqueléticos que resulta em gasto de energia” (Caspersen et al., 1985, p. 126). Caspersen define o exercício como um tipo de atividade física, planejada, estruturada e repetitiva, com o objetivo de melhorar um ou mais componentes da aptidão física (Caspersen et al., 1985).

Para prevenção de doenças e de mortalidade precoce, a Organização Mundial da Saúde (OMS), o Colégio Americano de Medicina do Esporte (ACSM) e a Associação Americana de Cardiologia (AHA) recomendam que adultos de 18 a 65 anos acumulem ao menos 30 minutos de atividade física moderada em pelo menos cinco dias da semana, ou 20 minutos de atividade física em intensidade vigorosa em três dias da semana (WHO, 2010; Haskell et al., 2007).

A OMS aponta que a inatividade física é responsável por mais de três milhões e duzentas mil mortes no mundo (5,5%), ocupando a quarta posição no *ranking* dos fatores de risco para mortalidade (OMS, 2009). Entretanto, em estudo publicado no *Lancet*, Lee e colaboradores atribuem à inatividade física 9% das mortes ocorridas no mundo, o que corresponde a 5,3 milhões de mortes (Lee et al., 2012).

A partir de dados coletados em 122 países, apresentados no *World Health Organization Global Health Observatory Sata Repository*, Hallal e colaboradores estimam que 31% dos adultos (com 15 anos ou mais) são fisicamente inativos (Hallal et al., 2012). Esse estudo mostra ainda que a prevalência de inatividade física aumenta entre os estratos de idade, tendo seus maiores valores entre os idosos acima de 60 anos.

Hallal (2012) observa que, além de não praticar atividade física nos nível recomendados para promover a saúde, a população tem passado grande parte do tempo sentada. Analisando 66 países de alta e baixa renda, a prevalência de adultos que gastam mais de 4 horas sentados é de 41,5%, variando de acordo com as regiões geográficas. Esse tempo despendido em

atividades sedentárias tem sido amplamente investigado nos últimos dez anos, na área de conhecimento em atividade física e saúde, recebendo o nome de “comportamento sedentário”.

O comportamento sedentário é definido como o tempo despendido em atividades na posição sentada ou inclinada que apresentem um gasto energético próximo aos níveis de repouso ou que envolvam menos de 1,5 unidades metabólicas (METs) (Pate et al., 2008).

Estudos recentes ressaltam que o comportamento sedentário é fator de risco para o aumento na incidência de doença coronariana, diabetes tipo 2 e mortalidade, independentemente do nível de atividade física (Beunza et al., 2007; Ford et al., 2012; Hu et al., 2001; Katzmarzyk et al., 2009; Dustan et al., 2010).

Algumas revisões sistemáticas têm sido publicadas nos últimos anos, buscando organizar os resultados sobre os efeitos do comportamento sedentário em crianças e adultos. Em adultos, existe evidência de associação entre o comportamento sedentário e a mortalidade por todas as causas; por diabetes do tipo 2; por eventos cardiovasculares fatais e não fatais, e por alguns tipos de câncer. Em crianças, o comportamento sedentário está associado à obesidade, hábitos insalubres de alimentação, desempenho acadêmica, saúde psicossocial e aptidão física. (Pearson; Biddle, 2011; Tremblay et al., 2011; van Uffelen et al., 2010; Thorp et al., 2010; Grøntved; Hu, 2011). No entanto, até o momento não há notícia sobre a sistematização das evidências sobre associação entre o comportamento sedentário e desfechos de saúde na população de idosos.

2. REVISÃO DA LITERATURA

2.1. Breve Histórico da Epidemiologia da Atividade Física

Para o campo da saúde coletiva, a epidemiologia da atividade física é uma área recente e em constante crescimento. Entretanto, a preocupação com a importância da atividade física para a saúde física, emocional, cognitiva e social da população é mais antiga (Florindo, 2011).

Antes de 2080 a.C., já constavam no Código de Hammurabi, rei da Babilônia, recomendações para o exercício físico (Dishman et al., 2013).

A Grécia Antiga foi considerada o berço da cultura corporal. Além do exercício físico utilizado para a preparação militar, a atividade física fazia parte da pedagogia que estimulava o desenvolvimento físico, pessoal e moral dos cidadãos. Platão (427/428-348 a.C.) discutiu detalhadamente a atividade física em duas de suas obras. Sua importância para a preparação militar foi discutida em *A República* e em *Timeo*, abordando a influência da atividade física na formação harmoniosa da personalidade.

Contemporâneo de Platão, Hipócrates (460-377 a.C.) foi considerado um dos primeiros estudiosos da atividade física, em um período no qual o pensamento lógico superava as bases sobrenaturais e religiosas (Hennekens; Buring, 1987). No livro *Corpus Hippocraticum*, Hipócrates descreveu que a alimentação e atividade física eram peças fundamentais para prevenção das doenças (Pereira, 1995; Hennekens; Buring, 1987).

Durante o primeiro século, Claudio Galeno (129-201) destacou-se pelos diversos tratados sobre anatomia, fisiologia, nutrição, exercícios físicos e efeitos deletérios de uma vida sedentária (Florindo, 2011). Galeno foi considerado o pai da Fisiologia do Exercício e publicou diversos livros, dentre os quais *A arte de preservar a saúde:* e*xercício e massagem*.

Destacaram-se também figuras como *Paracelsius* (1493-1541), com a primeira monografia sobre doenças ocupacionais (Paffenbarger et al., 2001); Giorlamo Mercuriali (1530-1606) e seu livro considerado o primeiro tratado médico da atividade física, *Arte da Ginástica entre os Antigos* (Grifi, 1989), e Bernardino Ramazzini (1633-1714), que relacionou saúde e doença entre trabalhadores e atletas em um dos primeiros estudos epidemiológicos (Paffenbarger et al., 2001).

Entre os séculos XIV e XIX, diversos médicos/educadores, como Leon Batttista, Narcurialis, Joseph Duchesne, Benjamin Rush, Edward Hitchcock, dentre outros, escreveram e recomendaram a prática de atividade física regular para a prevenção de doenças, melhoria da força muscular e reabilitação, incluindo esses conhecimentos na formação de médicos e profissionais de saúde (Dishman et al., 2013).

Entretanto, o advento da revolução industrial marcou a vida da sociedade, bem como os estudos epidemiológicos da atividade física. Diversos avanços tecnológicos, sociais e ambientais nos âmbitos do trabalho, do lazer e do transporte foram realizados, a fim de beneficiar a vida da população (Hennekens et al., 1987). No entanto, esses mesmos avanços

contribuíram para que as pessoas adotassem um estilo de vida sedentário (Hennekens; Buring, 1987; Pereira, 1995).

Considera-se o período do pós-guerra (anos 1950) como marco inicial dos estudos epidemiológicos da atividade física no âmbito da saúde coletiva, quando foram levantadas hipóteses de associação entre baixos níveis de atividade física e doenças cardiovasculares.

Jeremy Morris (1910-2009), considerado o precursor dos estudos epidemiológicos sobre atividade física, confirmou a inatividade física como fator de risco para doenças cardiovasculares em publicação no *Lancet* (Morris et al., 1953). Em seu estudo, uma coorte de motoristas e cobradores de Londres acompanhada durante dois anos, demonstrou maior incidência de angina, doença e morte por eventos cardiovasculares em motoristas (trabalho sedentário), quando comparados aos cobradores. Os cobradores tinham trabalho fisicamente ativo, já que percorriam o ônibus para solicitar o pagamento da passagem (Morris et al., 1953).

Inicialmente, o ceticismo de médicos e pesquisadores foi a reação predominante quando se referiam a esses resultados. Variáveis de confusão, como obesidade, hipertensão, hipercolesterolemia, e principalmente o estresse no trabalho, as quais não foram controladas, alimentavam esse ceticismo (Florindo, 2011). Posteriormente, o próprio Jeremy Morris conduziu diversas investigações mais cautelosas que confirmaram os resultados a favor do grupo fisicamente ativo (Morris; Crawford, 1958).

Desde então, diversos estudos epidemiológicos se ocuparam de investigar os efeitos da inatividade física na saúde da população. Desses, destacaram-se as coortes: *Framingham Heart Study*, *Tecumseh Community Health Study*, *Longshoremen Study*, *Aerobic Center Longitudinal Study*, *Nurses' Health Study e Harvard Alummni Study* (Dishman et al., 2013).

Todo esse ímpeto culminou na criação do *American College of Sports Medicine* (ACSM), em 1954. Essa instituição, com a presidência de importantes pesquisadores da área da atividade física como William Haskell, James Skinner, dentre outros, tem influenciado substancialmente o crescimento da epidemiologia da atividade física (Dishman et al., 2013).

A década de 1990 foi importante para o monitoramento e comparação da prática de atividade física moderada a vigorosa da população, pela validação do Questionário Internacional de Atividade Física (IPAQ) (Craig et al., 2003), e, posteriormente, com o Questionário de Atividade Física Global (GPAQ) (Bull et al., 2009). As evidências sobre os efeitos deletérios da inatividade física na saúde da população foram oriundas desses questionários, contribuindo para a construção de recomendações de prática de atividade física à população no cuidado da saúde (Pate et al., 1995).

No final do século XX e início do século XXI, alguns autores se destacaram no estudo do tema: Ralph Paffenbarger Jr. (1923-2007), com a coorte de estivadores de São Francisco e os estudantes da *Harvard Alumni* (Paffenbarger et al., 1978); I-Min Lee, professora de *Harvard*, que deu continuidade à coorte dos estudantes (Lee et al., 1995); Steven Blair, que contribuiu com centenas de publicações sobre a associação entre aptidão

cardiorrespiratória e prevenção de doenças crônicas (Blair et al., 1984), e mortalidade (Blair et al., 1989), e Russel Pate, com a primeira recomendação sobre atividade física publicada no *Journal of the Americam Medical Association (JAMA)* (Pate et al., 1995).

Na última década, e a partir de outro ponto de vista, a literatura tem focado o efeito do comportamento sedentário (sentar, assistir à televisão, deitar-se, usar o computador e videogame) sobre diversas doenças crônicas e sobre a mortalidade por todas as causas, independentemente do nível de atividade física (Hu et al., 2003; Thorp et al., 2010; Hamilton et al., 2007; Katzmarzyk et al., 2009, 2012; Dustan et al., 2010). Tal linha de pesquisa ganhou destaque a partir do estudo de Katzmarzyk e colaboradores, que relataram o acompanhamento de 17.013 canadenses de 18-90 anos. Após ajuste por possíveis variáveis de confusão, inclusive o nível de atividade física, o estudo mostrou que passar a maior parte do tempo sentado aumenta o risco de mortalidade por todas as causas e por doença coronariana, mas não por câncer. Os autores apresentaram resultados semelhantes, quando estratificados por sexo, idade, nível de tabagismo e IMC (Katzmarzyk et al., 2009). Desde então, a área de pesquisa do comportamento sedentário tem crescido substancialmente, sendo foco de revisões sistemáticas em crianças e adultos (Marshall et al., 2004; Tremblay et al., 2011; Grøntved; Hu, 2011; Proper et al., 2011).

2.2. Fisiologia do Sedentarismo

“Fisiologia da Inatividade” foi a expressão proposta por Hamilton e colaboradores em 2004, em revisão sobre alguns dos mecanismos biológicos que apontavam o comportamento sedentário como fator de risco emergente na saúde da população. A premissa básica dos autores foi a de que as consequências metabólicas do sedentarismo eram de natureza diferente da falta de atividade física (Hamilton et al., 2004). Até então, estudos de epigenética têm mostrado que diferentes regiões do genoma humano estão relacionadas a diferentes tipos de atividade física, sugerindo também mecanismos distintos de atuação (Simonsen et al., 2003).

Poucas são as evidências encontradas sobre os mecanismos fisiológicos do comportamento sedentário, com exceção da relação entre saúde e massa corporal, metabolismo e saúde óssea (Hamilton et al., 2004).

Desde 1967, estudos apontam que indivíduos obesos permanecem mais tempo sentados do que os magros (Bloom; Eidex, 1967). Em estudo clássico de Levine et al. (2005), 10 indivíduos magros e 10 obesos foram acompanhados por 10 dias, a fim de medir sua postura corporal e os movimentos por eles realizados. O estudo concluiu que indivíduos obesos ficam em média 2 horas mais sentados do que os magros, e que esse comportamento não se altera com uma diminuição de 10% do peso corporal. Nesse estudo, se os indivíduos obesos adotassem o mesmo padrão de comportamento que os seus pares, teriam um aumento no gasto energético

de 350 kcal/dia, o que resultaria menos 15 quilos de massa corporal no ano (Levine et al., 2005).

Mais recentemente, Duvivier et al. (2013), realizaram estudo randomizado cruzado com 18 adultos saudáveis, instruídos a seguir os seguintes regimes de atividade durante 4 dias cada: Regime sentado = 14 horas/dia sentado, 1 hora/dia para andar, 1 hora/dia em pé, 8 horas/dia na posição supina ou dormindo; Regime exercício físico = foi substituída 1 hora/dia do tempo sentado por 1 hora de pedalada vigorosa; Regime atividade física leve: substituir 6 horas do tempo sentado por 4 horas de caminhada de lazer e 2 horas em pé. Entre cada regime, foi realizado um intervalo de 10 dias. Os regimes de exercício físico e atividade física leve acarretaram em um acréscimo de aproximadamente 500 kcal/dia de gasto energético, quando comparados ao regime sentado, sendo 73 kcal/dia maior no regime atividade física leve em comparação ao exercício físico. Além disso, o regime atividade física leve teve uma redução na insulina durante o teste de tolerância à glicose oral (13%), nos triglicérides (22%), na fração de não HDL-colesterol (10%) e na Apoliproteína B (8%), quando comparados ao regime sentado. O estudo concluiu que o regime de atividade física leve foi o único que conseguiu compensar os efeitos negativos do tempo sentado sobre o nível de insulina e dos lipídios plasmáticos (Duvivier et al., 2013).

O principal mecanismo da relação entre o comportamento sedentário e o peso corporal é oriundo de experimentos com ratos. Os resultados desses experimentos mostraram que o comportamento sedentário diminui a capacidade de transporte de triglicérides na corrente sanguínea, devido à

baixa atividade muscular (principalmente do quadríceps). Essa diminuição do transporte de triglicérides esteve parcialmente relacionada à diminuição de 90% a 95% da ativação enzima Lipase Lipoproteica (LPL), uma das principais responsáveis pela oxidação de gorduras. Além disso, foi encontrada uma redução marcante nos níveis séricos de colesterol HDL (Bey et al., 2003; Hamilton et al., 1998; Zderic; Hamilton, 2006). Esses estudos mostraram ainda que os mecanismos genéticos e biológicos por meio dos quais o comportamento sedentário está relacionado à redução da ativação da LPL e do HDL são completamente distintos daqueles ativados pela falta de atividade física (Bey et al., 2003; Hamilton et al., 1998; Zderic; Hamilton, 2006). Por exemplo, a inibição da enzima LPL acarretada pelo comportamento sedentário está relacionada predominantemente a fibras musculares oxidativas, enquanto a inibição acarretada pela inatividade física está mais associada a fibras glicolíticas (Bey et al., 2003; Hamilton et al., 1998; Zderic; Hamilton, 2006).

A trombose venosa profunda é um exemplo de mecanismo fisiológico tipicamente relacionado ao comportamento sedentário. Trata-se de sério problema de saúde, potencialmente fatal, relacionado ao desenvolvimento de coágulos em veias profundas de músculos inativos (Simpson, 1940; Hamilton et al., 2007).

Estudos em biologia molecular mostraram que existem respostas biológicas específicas dessa condição relacionadas ao comportamento sedentário. Nesse sentido, mecanismos fisiológicos sugerem a incorporação das atividades físicas leves como parte do aconselhamento e da promoção

da saúde para prevenção da trombose venosa profunda (Simpson, 1940; Hamilton et al., 2007).

Estudos sobre o impacto do repouso na cama devido a tratamentos médicos ou cirúrgicos fornecem resultados interessantes sobre o efeito da inatividade muscular na saúde. Em um desses estudos, a redução da capacidade física de trabalho decorrente de três semanas de repouso foi equivalente a três décadas de envelhecimento. O mais interessante é que os mecanismos relacionados a essa redução foram distintos entre o repouso (diminuição do volume de ejeção e do débito cardíaco) e o envelhecimento (diminuição do consumo de oxigênio) (McGuire et al., 2001). Além disso, uma revisão de literatura mostrou que o repouso na cama está relacionado a mudanças neuro-humorais, intolerância ortostática, atrofia muscular e distúrbio do balanço dos fluidos (Pavy-Le et al., 2007). É importante ressaltar as relações encontradas nesses estudos, quase sempre decorrentes de uma exposição ao repouso na cama por diversos dias.

Esses achados apontam para a necessidade de uma atualização nas recomendações de atividade física para a população, uma vez que atualmente elas não levam em conta os potenciais efeitos deletérios do comportamento sedentário sobre a saúde. Por conseguinte, futuros estudos e debates sobre “quanto o tempo em comportamento sedentário” aumenta substancialmente o risco da saúde da população devem ser estimulados (Hamilton et al., 2008).

2.3. Epidemiologia do Comportamento Sedentário

Este item tem por objetivo descrever as características gerais do comportamento sedentário na população, particularmente em relação aos três elementos da epidemiologia: pessoa, lugar e tempo (Hennekens; Buring, 1987). Quanto à “pessoa”, serão incluídos fatores sociodemográficos como sexo, idade e nível socioeconômico. As características de lugar referirão basicamente à distribuição geográfica, particularmente entre países. E em relação ao tempo, apesar de um tópico ainda recente, será traçado um padrão da distribuição do comportamento sedentário ao longo dos anos.

Antes dessa descrição do comportamento sedentário, faz-se necessária breve reflexão sobre as formas de mensuração. Caspersen, Powell e Christenson reportam que “o estudo epidemiológico de qualquer conceito ou evento exige que o item sob investigação seja definido e mensurado” (Caspersen et al., 1985, p. 126).

Há consenso quanto à definição de comportamento sedentário entre pesquisadores da área. São atividades nas posições sentada ou inclinada, que apresentam um gasto energético próximo dos níveis de repouso ($\leq$1,5 METs) (Pate et al., 2008; SBRN, 2012). Assim como a atividade física, as atividades sedentárias podem ser divididas em diferentes domínios: trabalho, transporte, escola/universidade e lazer (Mielke, 2012). Sem dúvida, apesar desses diferentes domínios, o tempo sentado total, o tempo diante de aparelho de televisão e do computador são os comportamentos mais

investigados na literatura, uma vez que apresentam melhor avaliação psicométrica (validade, reprodutibilidade e objetividade) (Atkin et al., 2012).

Quanto à mensuração, os estudos carecem de padronização e operacionalização. Além dos diferentes domínios já citados, questões como o tempo a que se reporta o comportamento sedentário (dia típico da semana, última semana, mês, ano) e a distribuição na semana (dia de semana e final de semana) ainda não apresentam consenso na literatura (Atkin et al., 2012). Em geral, esses instrumentos subjetivos apresentam reprodutibilidade moderada, e entre moderada e baixa validade (Atkin et al., 2012). Apesar disso, é importante ressaltar que esses instrumentos não conseguem capturar o contexto biopsicossocial em que a mensuração está inserida, classificando a atividade somente pelo gasto energético, mas pelo contexto multidimensional a que pertence (Gabriel et al., 2012).

Em relação às medidas objetivas, os acelerômetros são os instrumentos mais utilizados para avaliar o comportamento sedentário. Apesar de oferecer medida objetiva, muitos desses aparelhos apresentam importantes limitações acerca da detecção da postura do indivíduo, critério fundamental, uma vez que está diretamente relacionado ao conceito de comportamento sedentário. Entretanto, alguns desses dispositivos da linha *ActivPAL*[1] têm apresentado melhor capacidade de identificar tempo sentado e em pé (Atkin et al., 2012).

Outra questão importante diz respeito ao tratamento dos dados no momento da análise. Apesar de o comportamento sedentário ser

[1] Modelo de acelerômetro muito utilizado para quantificar o tempo despendido em atividades ambulatoriais e sedentárias diárias.

caracterizado por uma variável fundamentalmente contínua, a maioria dos estudos o utiliza como variável ordinal ou mesmo dicotômica. Diversas razões lógicas, estatísticas e filosóficas indicam esse aspecto como limitação importante na categorização dessas variáveis (Dinero, 1996; Altman; Royston, 2006). Exemplo disso: quando o tempo de televisão é categorizado em <120 e ≥120 minutos/dia, está sendo considerado que os sujeitos que permanecem 199 minutos/dia nessa atividade devam ser enquadrados no mesmo grupo daqueles que não assistem à televisão. Entretanto, se, apesar das limitações da categorização, ela ainda for escolhida como procedimento, devem-se utilizar pontos de corte que expressem a relação dose-resposta, além de intervalos menores e grupos mais semelhantes entre si, possibilitando uma observação mais gradual da relação entre o comportamento sedentário e os desfechos em saúde.

Nesse sentido, quando analisada a característica do comportamento sedentário na população segundo os elementos da epidemiologia (pessoa, lugar tempo), deve-se levar em consideração o domínio (trabalho, transporte, escola/universidade e lazer), o tipo (televisão, computador, tempo sentado total), o instrumento utilizado (questionário ou acelerômetro) e o tratamento da variável (contínua ou categórica).

2.3.1. Pessoa

Conhecer os grupos populacionais mais expostos ao comportamento sedentário é essencial para o desenvolvimento de intervenções.

Com relação ao sexo, a exposição ao comportamento sedentário entre homens e mulheres parece variar de acordo com a localização (Bauman et al., 2011). Em estudo realizado em 20 países do mundo (*International Prevalence Study* – IPS), o tempo sentado total foi maior entre os homens, em 7 países (Brasil, Colômbia, China, Bélgica, Espanha, Arábia Saudita, Índia). As mulheres estavam mais expostas em 5 países (República Tcheca, Hong Kong, Lituânia, Taiwan, Japão). Nos demais, não houve diferença entre os sexos (Portugal, Austrália, Nova Zelândia, Estados Unidos da América, Argentina, Canada, Suécia, Noruega) (Bauman et al., 2011). De forma semelhante, em pesquisa com dados do "*WHO STEPwise approach to chronic disease risk factor surveillance*" (STEPS), Hallal et al. (2012) não encontraram diferença entre sexos na exposição ao comportamento sedentário (≥4 horas de tempo sentado no dia) (Hallal et al., 2012).

No Brasil, os principais dados sobre exposição ao comportamento sedentário (hábito de assistir à televisão) são oriundos do Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico (VIGITEL). Os dados do *VIGITEL 2011* mostraram que a exposição ao hábito de assistir à televisão por 3 ou mais horas foi semelhante entre homes (27,9%) e mulheres (26,4%) (Brasil, 2012).

Em escolares, a exposição ao comportamento sedentário também parece ser semelhante entre os sexos. Estudo de Guthold et al. (2010), avaliou o comportamento sedentário em 34 países, utilizando dados do *Global School-Based Student Health Survey* (GSHS) Os resultados mostraram que 32,7% dos meninos e 34,5% das meninas permaneciam

mais de 3 horas por dia sentados assistindo à televisão, jogando no computador ou videogame, brincando com os amigos ou fazendo sentados qualquer outra atividade. A maior exposição ao comportamento sedentário em meninas foi particularmente mais acentuada em países da América (Guthold et al., 2012).

Em outro estudo realizado nos Estados Unidos da América e em países europeus (*Health Behavior in School-aged Children* – HBSC), verificou-se que 70% dos meninos e 69% das meninas de 13 anos de idade ficavam mais de 2 horas assistindo à televisão, enquanto os adolescentes de 15 anos ficavam 69% e 67%, respectivamente (WHO, 2008).

Em relação à idade, o comportamento sedentário parece aumentar substancialmente de acordo com as faixas etárias. Em estudo de Bauman e colaboradores (IPS), o tempo sentado foi maior em adultos de meia-idade (40 a 65 anos) do que em jovens adultos (18 a 39 anos) (Bauman et al., 2011). Similarmente, Hallal et al. (2012) (STEPS) encontraram o grupo de $\geq$ 60 anos como o mais exposto ao comportamento sedentário (Hallal et al., 2012). Na Austrália, homens e mulheres acima de 65 anos assistem à televisão sentados 4 horas em média. Isso representa aproximadamente 2 horas a mais do que homens e mulheres entre 25 e 64 anos de idade (Australia Bureau Statistics, 1998). Nos Estados Unidos da América, adultos acima de 60 anos passam cerca de 8-9 horas/dia em comportamento sedentário, enquanto adultos de 20-59 anos passam 5-7 horas/dia (Matthews et al., 2008).

No Brasil, os dados do *VIGITEL 2011* não mostraram associação linear entre hábito de assistir à televisão (≥3 horas/dia) e a idade. Nesse inquérito, os grupos mais expostos ao hábito de assistir à televisão foram os de 18-24 anos (31,5%) e os de 65 anos ou mais (31,8%) (Brasil, 2012).

Quando avaliada a relação entre o nível socioeconômico e o comportamento sedentário, estudos apontam para uma relação inversa (Mielke, 2012; Bowman, 2006; Sugiyama et al., 2008; Chang et al., 2008). Entretanto, conforme reportado anteriormente, essa relação depende do domínio e do tipo de comportamento sedentário utilizado. Por exemplo, estudo realizado em Pelotas mostrou que, em geral, indivíduos com maior escolaridade e condição socioeconômica estavam mais expostos ao comportamento sedentário (Mielke, 2012). Essa relação esteve presente, principalmente quando analisado o tempo de uso do computador em casa, o tempo sentado no trabalho e na escola/universidade. Entretanto, o tempo de televisão foi maior entre os indivíduos com nível socioeconômico mais baixo (Mielke, 2012). Os dados do *VIGITEL 2011* dão suporte a esses resultados, mostrando que os indivíduos de 0 a 8 anos de escolaridade (28%) são mais expostos do que os de 12 anos ou mais (20,8%) (Brasil, 2011).

2.3.2. Lugar

Utilizando dados do STEPS (66 países), Hallal e colaboradores estimaram que a prevalência global de adultos com mais de 4 horas por dia sentados é de 41,5% (IC 95% 41,3–41,7). Entre as regiões geográficas

definidas pela OMS, os pesquisadores observaram que a Europa é a mais exposta (64,1%; IC 95% 63,5–64,7), seguida das Américas (55,2%; IC 95% 54,3–56,1), Leste Mediterrâneo (41,4%; IC 95% 40,1–42,7), Oeste do Pacífico (39,8%; IC 95% 39,3–40,3), África (37,8%; IC 95% 37,4–38,2) e Sudeste da Ásia (23,8%; IC 95% 23,1–24,5) (Hallal et al., 2012).

No estudo IPS (20 países), Bauman et al. identificaram que Portugal, Brasil, Colômbia e China foram os países com menos adultos expostos ao tempo sentado (mediana <210 minutos/semana). Austrália, China, Nova Zelândia e Estados Unidos da América apresentaram mediana de 240 minutos/semana; Argentina, Bélgica, Canada, Espanha e Suécia tiveram mediana de 300 minutos/semana; República Tcheca, Lituânia, Hong Kong, Noruega e Taiwan tiverem 360 minutos/semana de mediana. Finalmente, Japão e Arábia Saudita foram os países mais expostos nesse inquérito (mediana de 420 minutos/semana) (Bauman et al., 2011). No Brasil, no último inquérito do VIGITEL, constatou-se que a prevalência de adultos que assistem à televisão 3 horas ou mais por dia foi de 26,4% (Brasil, 2013).

Em crianças, a prevalência de 3 ou mais horas de comportamento sedentário (televisão, computador, videogame, sentado com os amigos, ou fazendo outras atividades sentadas) foi investigada em 34 países, por meio do *Global School-Based Student Health Survey* (GSHS). Nesse estudo, a prevalência variou de 12,7% em Myanmar a 57,5% em Saint Lucia. Além disso, países como Ilhas Cayman, Colômbia, Saint Lucia, Seychelles, Argentina, Chile, Trinidad e Tobago e Uruguai tiveram mais de 50% de

meninos e/ou meninas que ficavam mais de 3 horas em comportamento sedentário (Guthold et al., 2010).

2.3.3. Tempo

Em relação ao tempo, poucos estudos tentaram traçar um padrão da distribuição do comportamento sedentário ao longo dos anos, por se tratar de um tópico ainda recente.

Na Dinamarca, estudo com adultos de 25 a 79 anos examinou as mudanças dos domínios do comportamento sedentário entre 2007 e 2010. Em 2007, o inquérito constatou que esses adultos permaneciam em média 3,4 horas sentados no lazer e 4,4 horas no trabalho. Em 2010, a média de tempo sentado no lazer e no trabalho aumentou em 12,6 e 13,2 minutos, respectivamente (Aadahl et al., 2013).

Em Sydney (Austrália), estudo de Sugiyama et al. (2012) analisou o tempo sentado no carro, usando dados do "*Sydney Greater Metropolitan Area Household Survey*" dos anos de 1997-1999, 2000-2002, 2003-2005 e 2006-2008. O estudo mostrou que a prevalência de tempo sentado no carro foi de 16%-18% em homens e 10%-12% nas mulheres. Os dados de tendência mostraram que o tempo sentado foi estável entre os homens, mas aumentou entre as mulheres (de 10,3%, em 2007, para 11,4%, em 2006-2008) *(Sugiyama et al., 2012).*

Em estudo realizado na Holanda entre 1975 e 2005, van der Ploeg et al. (2013) avaliaram a tendência do comportamento sedentário fora do

trabalho com dados do *National Time Use Survey of the Netherlands*. Nesse período, a proporção de pessoas engajadas em atividades sedentárias fora do trabalho se manteve constante (60%). A maior parte desse comportamento sedentário foi oriundo de atividades de tela [2] que aumentaram de 26%, em 1975, para 43%, em 2005 (van Der Ploeg et al., 2013).

Na região Libérica, a tendência do tempo sentado total foi avaliada entre 2002 e 2009, medida por meio do IPAQ. O estudo mostrou que o tempo sentado em dias de semana diminuiu tanto em homens (aproximadamente 200 minutos) quanto em mulheres (aproximadamente 100 minutos) (Dagmar et al., 2011).

No Brasil, o VIGITEL incorporou no inquérito questões sobre hábito de assistir à televisão desde 2009. Os resultados desse inquérito mostraram-se instáveis, com 28,3% da população assistindo à televisão 3 ou mais horas em 2009; 25,8%, em 2010; 27,1%, em 2011, e 26,4%, em 2012 (Brasil, 2010; 2011; 2012; 2013).

Em crianças, estudos de tendência do comportamento sedentário são ainda mais raros. Nos Estados Unidos da América, inquéritos representativos foram conduzidos em 2001-2002, 2005-2006 e 2009-2010 com adolescentes de 11 a 16 anos. Os resultados do estudo realizado mostraram que o tempo de televisão por dia diminuiu de 3,06 horas, em 2001-2002, para 2,65 horas, em 2005-2006, e 2,38 horas, em 2009-2010. Entretanto, o tempo de videogame aumentou de 1,19 hora/dia, em 2001-

[2] Entende-se por atividades de tela a soma do tempo gasto diante da televisão, do computador e do vídeogame.

2002, para 1,29 hora/dia, em 2009-2010. Similarmente, o tempo de computador também aumentou de 1,41 hora/dia, em 2005-2006, para 1,51 hora/dia, em 2009-2010 (Iannotti; Wang, 2012).

De forma semelhante, a tendência de comportamento sedentário foi analisada na República Tcheca em crianças de 11 a 15 anos de 2002 a 2010. O estudo mostrou um aumento do tempo de uso do computador em meninas (0,7 hora/dia, em 2002, para 3 horas/dia em 2010) e em meninos (1,6 hora/dia, em 2002, para 4 horas/dia, em 2010). Os tempos de televisão (2,3 horas/dia) e videogame (3,3 horas/dia) permaneceram estáveis ao longo dos anos (Sigmundová et al., 2013).

Esses resultados, ainda que insipientes, mostram que diferentes tipos de comportamento sedentário apresentam diferentes padrões de distribuição ao longo dos anos, dependendo também da região pesquisada.

2.4. Envelhecimento, Atividade Física e Comportamento Sedentário

Com o aumento da expectativa de vida no mundo e consequente envelhecimento da população, o desafio atual das sociedades tem sido adicionar “vida” aos anos de vida dos idosos (Bowling, 2009).

Nos últimos anos, a atividade física tem recebido destaque no cenário científico, mostrando-se um dos mais importantes fatores para atingir o envelhecimento saudável, não relacionado somente à ausência de doenças mas à autonomia física e às funções cognitiva, afetiva e social preservadas (Rowe; Kahn, 1997).

Pesquisas envolvendo exercício, atividade física e envelhecimento têm sido amplamente realizadas pela academia. Como produtos dessas investigações, posicionamentos e recomendações de instituições, como o *American College of Sports Medicine* (ACSM), o *American Heart Association* e a *World Health Organization*, têm sido produzidos nos anos recentes (Wojtek et al., 2009; Nelson et al., 2007; WHO, 2010). Em linhas gerais, essas instituições recomendam que idosos acumulem pelo menos 150 minutos de atividade física em intensidades correspondentes à aptidão física cardiorrespiratória. Além das atividades físicas de *endurance*, são recomendados exercícios resistidos, de flexibilidade e de equilíbrio na frequência e intensidade que seguem:

Endurance:

- Frequência e duração: 30 a 60 minutos de atividade física por dia, em blocos de pelo menos 10 minutos, acumulando 150 a 300 minutos por semana de atividade física; entre 20 a 30 minutos de atividade física vigorosa por dia, acumulando um total de 75 a 150 minutos por semana;
- Intensidade: Em uma escala de 0 a 10, 5 a 6 para atividades físicas moderadas, e 7 a 8 para vigorosas.
- Tipo: Qualquer tipo que não acumule excesso de estresse ortopédico: caminhada, atividades aquáticas, cicloergômetro.

Exercícios Resistidos:

- Frequência: pelo menos 2 dias por semana;
- Intensidade: em uma escala de 0 a 10, 5 a 6 para atividades físicas moderadas, e 7 a 8 para vigorosas.
- Tipo: exercícios resistidos (8 a 10 exercícios envolvendo grandes grupos musculares, com 8 a 12 repetições para cada exercício).

Flexibilidade:

- Frequência: pelo menos 2 dias por semana;
- Intensidade: 5 a 6, em uma escala de 0 a 10.
- Tipo: alongamentos estáticos e balísticos que mantenham ou aumentem a flexibilidade.

Equilíbrio:

Recomendado principalmente para indivíduos que sofreram quedas ou que apresentam problemas de mobilidade. Devido ao menor acúmulo de evidências quanto a esse tipo de exercício, não existem recomendações específicas para frequência, intensidade e tipo. Entretanto, o ACSM recomenda:

a) posturas que gradualmente reduzam a base de apoio; b) movimentos dinâmicos que mudem o centro de gravidade; c) exercitar grupos musculares relacionados à postura; d) reduzir a estímulos sensorial (por exemplo, em pé, com os olhos fechados).

Apesar de grande parte de a literatura abordar os benefícios das atividades acima citadas, evidências emergentes sobre os benefícios das atividades físicas leves, principalmente nos idosos, têm mostrado que essa é uma excelente estratégia de promoção de estilo de vida ativo, principalmente pela relação inversa que apresenta em relação ao comportamento sedentário.

Em geral, sabe-se que o gasto energético de indivíduos adultos é compreendido pela taxa de metabolismo basal (60%), efeito termogênico da ingestão dos alimentos (10%-15%) e gasto energético decorrente de atividades físicas (30%). As atividades físicas, por sua vez, podem ser divididas entre aquelas relacionadas com a prática de exercício físico e outras atividades que não envolvem exercício (*non-exercise activity termogenesis - NEATs*) (Levine, 2002).

As NEATs podem ser divididas em atividades bem antagônicas: (a) comportamentos sedentários, com equivalente metabólico de 1,0 a 1,5 *Metabolic Energy Tasks* (METS); e (b) atividades leves que não caracterizam exercício físico (por exemplo, atividades de deambulação) com MET de 1,6 a 2,9 (Levine, 2002). Evidências emergentes de atividades físicas leves têm mostrado que essas podem contribuir substancialmente para o balanço energético, e a saúde física e metabólica (Levine et al., 2005; Buman et al., 2010; Gando et al., 2010).

Buman e colaboradores avaliaram a relação entre a prática de atividade física leve e a saúde de idosos. Nesse estudo, 862 sujeitos foram avaliados quanto à pratica de atividade física leve durante 7 dias, por meio

do uso do acelerômetro. Após 6 meses da avaliação da prática de atividade física leve, os sujeitos responderam um questionário com perguntas sobre qualidade de vida, autoavaliação da saúde e variáveis psicossociais. Após ajustar por possíveis variáveis de confusão, inclusive a prática de atividade física moderada e vigorosa, a prática de atividade física leve esteve associada à saúde física e ao bem-estar dos idosos. O estudo encontrou ainda que, trocando-se 30 minutos de comportamento sedentário por atividade física leve, isso já proporcionaria benefícios substanciais à saúde física e bem-estar dos idosos (Buman et al., 2010).

Em estudo de Gando et al. (2010), 538 idosos saudáveis foram avaliados quanto à prática de atividade física (acelerômetro) e o *stiffness*[3] da artéria. Os resultados mostraram que a velocidade da onda da pulsação entre as artérias carótida e femoral esteve correlacionada ($r = -0,47$; $p<0,01$) ao tempo gasto em atividade física leve em idosos com baixa aptidão cardiorrespiratória. Esses resultados sugerem que a atividade física leve tem um importante papel na redução do *stiffness* arterial, considerado fator de risco de eventos cardiovasculares fatais e não fatais (Gando et al., 2010).

Além desses benefícios, estudos têm mostrado que a atividade física leve tem importante papel na prevenção de doenças e morte precoce (Elosua et al., 2013; Lollgen et al., 2009; Woodcock et al., 2011).

Em recente estudo caso-controle realizado na Espanha, Elosua e colaboradores avaliaram a relação dose-reposta da prática de atividade física e o infarto agudo do miocárdio, considerando as diferentes

[3] *Stiffness* é a rigidez de um objeto. Por exemplo, uma artéria que tende a resistir à deformação em resposta a uma força aplicada.

intensidades (leve, moderada e vigorosa) e as possíveis modificações de efeito com a idade. O estudo avaliou 1.339 casos (pessoas que tiveram infarto do miocárdio) e 1.339 controles pareados por sexo e idade, selecionados de forma aleatória na população, e avaliou a prática de atividade física. Os resultados do estudo mostraram que a prática de atividade física teve uma relação não linear com o infarto agudo do miocárdio, mostrando que a maior proteção acontece da mudança da condição de inativo para alguma prática de atividade física na semana. O estudo mostrou ainda que a prática de atividade física leve oferece benefícios similares aos da moderada e vigorosa, em indivíduos a partir de 64 anos de idade (Elosua et al., 2013).

Recentemente, duas meta-análises (Lollgen et al., 2009; Woodcock et al., 2011) avaliaram a associação entre a prática de atividade física em diferentes intensidades e a mortalidade por todas as causas. Ambas as revisões encontraram uma relação dose-resposta entre a prática de atividade física, em qualquer intensidade, e a mortalidade por todas as causas. Os autores afirmaram ainda que poucos são os benefícios adicionais do incremento na intensidade dessas atividades. Resultados semelhantes foram encontrados em análises de subgrupos nos quais foram avaliados idosos acima de 65 anos e mulheres. Ambas as revisões afirmaram que aumentar o gasto energético ou a intensidade das atividades pode melhorar a aptidão física, mas isso não fornece benefícios adicionais para a redução na mortalidade por todas as causas.

Além disso, é preciso ressaltar o grande potencial das atividades físicas leves na redução do comportamento sedentário. Grande parte do tempo gasto em comportamento sedentário é atribuído à mudança no tempo das atividades físicas leves, havendo correlação moderada/alta e negativa entre essas atividades (CDC, 2010; Owen et al., 2010; Healy et al., 2008a; Montgomery et al., 2004).

Examinando-se dados de 7 dias de acelerometria, o *US National Health and Nutrition Examination Survey* (NHANES), foi possível identificar a seguinte distribuição de tempo, segundo intensidade das atividades diárias: 58% em comportamento sedentário, 39% em atividades físicas leves e 3% em exercícios físicos (CDC, 2010). Avaliando os quartis de comportamento sedentário, foi possível verificar que a maior parte da variância dessas atividades sedentárias entre os quartis esteve relacionada a atividades físicas leves.

Dados da Austrália confirmam esses achados, mostrando que o comportamento sedentário e as atividades físicas leves apresentam uma correlação forte e negativa (r = -0,96) (Healy et al., 2008a). Sem dúvida, nas últimas décadas, diversas atividades leves foram substituídas por comportamento sedentário, o que contribuiu substancialmente para o aumento do risco metabólico na população.

Para ilustrar como as atividades físicas leves podem contribuir para a diminuição do risco do comportamento sedentário sobre a saúde da população, principalmente de idosos, estudo de Healy e colaboradores mostrou que as quebras no comportamento sedentário (Healy et al., 2008b)

(interrupção do comportamento sedentário ou *counts*/min >100) podem ser uma importante iniciativa. Nesse estudo, 168 pessoas com idade média de 53 anos foram recrutadas do *Australian Diabetes, Obesity and Lifestyle Study*. O tempo em comportamento sedentário e suas quebras foram avaliados por meio do acelerômetro. Os resultados desse estudo mostraram que as quebras no comportamento sedentário estiveram associadas à menor circunferência de cintura (β 0,16; IC 95% 0,31 - 0,02; p=0,026), ao índice de massa corporal (β 0,19; IC 95% 0,35 - 0,02; p=0,026), à triglicérides (β 0,18; IC 95% 0,34 - 0,02; p=0,029), e à glicose plasmática (β 0,18; IC 95% 0,34 - 0.02; p=0,025), independentemente do tempo em comportamento sedentário e da prática de atividade física moderada a vigorosa.

Esses resultados sugerem que o monitoramento populacional, pesquisas, políticas públicas e programas de promoção de atividade física devam incorporar futuramente a atividade física leve em suas atividades.

3. JUSTIFICATIVA

A exposição ao comportamento sedentário tem sido amplamente investigada na última década. Diversas revisões sistemáticas têm investigado evidências sobre a associação entre comportamento sedentário e desfechos na saúde de crianças, adolescentes (Leblanc et al., 2012; Tremblay et al., 2011; Marshall et al., 2004) e adultos (Rhodes et al., 2012; Thorp et al., 2012; Grøntved; Hu, 2011; Wilmot et al., 2012; Lynch, 2010). Entretanto, essas revisões apresentam algumas limitações. Primeiramente, algumas delas não avaliam a qualidade das evidências dos artigos revisados (Thorp et al., 2012; Grøntved; Hu, 2011). Além disso, revisões especialmente com adultos incluíram sujeitos com uma faixa etária ampla (por exemplo, ≥18 anos) (Rhodes et al., 2012; Thorp et al., 2012; Grøntved; Hu, 2011; Wilmot et al., 2012; Lynch, 2010). Esse critério de inclusão assume que os efeitos deletérios atribuíveis ao comportamento sedentário são similares entre adultos (por exemplo, 18-59 anos) e idosos (≥ 60 anos). Entretanto, tem sido observado que alguns fatores de risco cardiovascular (por exemplo, tabagismo, obesidade e consumo de álcool) são menos preditivos em desfechos de saúde, como a mortalidade em idosos (Nybo et al., 2003), justificando uma análise específica desse grupo etário.

Ademais, em comparação com outros grupos etários, idosos são os mais sedentários. Na Austrália, homens e mulheres acima de 65 anos assistem à televisão sentados durante 4 horas, em média. Isso representa

aproximadamente 2 horas a mais do que homens e mulheres entre 25 e 64 anos de idade. (Australia Bureau Statistics, 1998). Nos Estados Unidos da América, adultos acima de 60 anos passam cerca de 8-9 horas por dia em comportamento sedentário, enquanto adultos de 20-59 anos passam de 5-7 horas por dia (Matthews et al., 2008). Resultados de estudos europeus também reportam que o tempo em sedentarismo é maior nos grupos acima de 65 anos (Davis et al., 2011). Da mesma forma, Hallal et al. realizaram avaliação em mais de 60 países e reportaram que os idosos apresentam a maior prevalência de relatar um mínimo de 4 horas de tempo sentados por dia (Hallal et al., 2012). Apesar dessa alta exposição nos idosos, os efeitos do comportamento sedentário sobre a saúde da população ainda não foram objeto de revisão.

4. OBJETIVO

Revisar sistematicamente evidências de associação entre o comportamento sedentário e desfechos de saúde em idosos acima de 60 anos de idade.

5. MÉTODOS

5.1. Delineamento do Estudo

Nas últimas décadas, o crescimento de publicações científicas, bem como sua divulgação, tem aumentado substancialmente no cenário mundial (Larsen; Ins, 2010). Revisões de literatura tornaram-se fundamentais para sumarizar evidências e possibilitar futuras tomadas de decisão clínicas e científicas (Nobre; Bernardo, 2006).

Entretanto, revisões narrativas comumente encontradas na literatura fornecem na maior parte das vezes a perspectiva do autor sobre a interpretação dos resultados disponíveis. Isso ocorre, pois elas não apresentam uma forma padronizada de seleção, extração de dados e avaliação das evidências (Egger et al., 2001a).

Revisões sistemáticas procuram analisar todas as investigações sobre questões específicas que cumprem critérios de elegibilidade pré-estabelecidos (Green et al., 2011). Além disso, as revisões sistemáticas apresentam métodos explícitos de seleção de artigos, extração de dados e avaliação de qualidade, a fim de minimizar vieses, produzir achados reprodutíveis e conclusões que correspondam aos resultados apresentados na literatura internacional (Green et al., 2011; Egger et al., 2001a).

A história das revisões sistemáticas não é recente, uma vez que a primeira meta-análise foi publicada por Karl Pearson no *British Medical*

Journal (BMJ) em 1904, abordando a síntese de 2 estudos sobre inoculação de febre entérica (Pearson, 1904). Entretanto, somente a partir de 1938 foram publicados artigos metodológicos sobre análises estatísticas para combinação de resultados de diferentes estudos (Yates; Cochran, 1938), e somente em 1976 surgiu o termo meta-análise (Glass, 1976).

A consagração das revisões sistemáticas na área da saúde consolidou-se somente no final da década de 1980, com a publicação do livro *Effective Care During Pregnancy and Childbirth* (Chalmers et al., 1989), o qual se tornaria posteriormente tema do logotipo do Centro Cochrane. Após a grande disseminação das revisões sistemáticas pelo Centro Cochrane, fundado em 1922, emergiram diversas publicações com essa metodologia. Em 1999, pesquisadores participaram da elaboração e publicação do QUOROM (*QUality Of Reporting Of Meta- analyses*), o primeiro *checklist* para escrita de revisões sistemáticas, com o objetivo de melhorar a qualidade dessas publicações em relação à transparência de suas limitações e virtudes (Moher et al., 1999). Em 2009, o PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) foi publicado, a fim de atualizar essas diretrizes para a escrita de revisões sistemáticas. Ambos os *checklists* apresentam enfoque em revisões de ensaios clínicos, pois elas apresentam grande parte do corpo de evidências, além de apresentarem forte evidência científica. Entretanto, perguntas sobre etiologia das doenças frequentemente não podem ser testadas em estudos experimentais, por questões éticas (Egger et al., 2001a). Por exemplo, trabalhos que têm por objetivo avaliar o comportamento sedentário como

fator de risco para doenças crônicas não transmissíveis necessitam de um delineamento observacional (Egger et al., 2001a).

Devido às peculiaridades de delineamento dos estudos observacionais, pesquisadores se reuniram para escrever um *checklist* para direcionar a escrita de revisões sistemáticas de estudos observacionais - *Meta-analysis Of Observational Studies in Epidemiology* (MOOSE) (Stroup et al., 2000), orientando os leitores às particularidades dos resultados desses estudos. Algumas dessas diretrizes para escrita e execução de revisões sistemáticas de estudos observacionais, bem como peculiaridades e dificuldades envolvidas, serão delineadas a seguir.

5.2. Formulação da Pergunta

A formulação da pergunta da pesquisa é uma das etapas importantes da revisão sistemática, para garantir objetividade à mesma. (O'Connor et al., 2011; Nobre; Bernardo, 2006)

Diversas publicações recomendam a utilização do acrônimo PICO para a formulação da pergunta da pesquisa com objetivo terapêutico ou preventivo (O'Connor et al., 2011; Nobre; Bernardo, 2006):

P População: população específica, bem como situação clínica incluída nos estudos primários.

I Intervenção: definição da intervenção de interesse investigada.

C Controle: grupo controle utilizado como comparador.

O Desfecho (*Outcome*): desfechos de interesse para investigação da intervenção.

Além desses itens, Nobre et al. (2006) incluem em suas recomendações a letra T, referente ao tempo em que a intervenção foi testada (Nobre; Bernardo, 2006).

Entretanto, nenhum desses materiais disponibiliza diretrizes para formulação de perguntas de pesquisa sobre etiologia, fatores de risco e prognóstico para desenvolvimento de revisões sistemáticas de estudos observacionais. Portanto, durante a realização dessa dissertação de mestrado, foi elaborada uma primeira proposta para adaptação do PICO, para formulação da pergunta no âmbito dos estudos observacionais. Em substituição à intervenção, considerou-se a exposição, e, em substituição ao controle, considerou-se o delineamento do estudo, formando o acrônimo PEOD.

P População: população específica, bem como situação clínica incluída nos estudos primários.

E Exposição: definição da exposição de interesse investigada.

O Desfecho (*Outcome*): desfechos de interesse para investigação da exposição.

D Delineamento: delineamento do estudo utilizado para investigar o efeito da exposição no desfecho de interesse.

A formulação da pergunta desta revisão sistemática foi realizada por meio da estratégia PEOD, seguindo os seguintes critérios:

População: Idosos com idade acima de 60 anos.

Exposição: Comportamento sedentário com medida específica segundo a definição de Pate et al.(2008) (Glossário).

***O**utcome:* Desfechos primários: mortalidade, doenças cardiovasculares, câncer e diabetes tipo 2.

Desfechos secundários: quedas, fragilidade, obesidade, síndrome metabólica, distúrbios mentais e musculoesqueléticos.

Delineamento: Estudos transversais, caso-controle e coortes prospectivas e retrospectivas.

O método da revisão sistemática prevê que as publicações que fazem parte do material empírico da pesquisa devam ser definidas a priori, de acordo com os critérios de elegibilidade (O'Connor et al., 2011; Nobre; Bernardo, 2006) e com base na pergunta da pesquisa. Nesta pesquisa

nenhum idioma ou data limite foi imposto para que todos os artigos encontrados fossem avaliados. No entanto, foram excluídos da pesquisa estudos que: (a) incluíam adultos com menos de 60 anos na amostra; (b) não incluíam atividade física como uma covariável, e (c) apresentavam somente uma análise descritiva do comportamento sedentário.

5.3. Estratégia de Busca

Para identificação de todas as publicações, é de extrema importância fazer busca nas principais bases de dados, bem como usar descritores previamente selecionados, relacionados a cada um dos componentes do PICO ou do PEOD. No Quadro 1, está a relação das principais bases de dados da área de saúde (Pellizzon et al., 2003; O'Connor et al., 2011; Nobre; Bernardo, 2006).

Quadro 1. Principais bases de dados para busca de evidências científicas

Base de Dados	Site	Finalidade
MEDLINE	http://www.ncbi.nlm.nih.gov/pubmed/	Literatura Biomédica e Saúde
EMBASE	www.embase.com/	Literatura Biomédica e Saúde
CENTRAL	www.thecochranelibrary.com/	Medicina e Cuidado Saúde
LILACS	lilacs.bvsalud.org/	Literatura Científica América Latina e Caribe
PSYCHINFO	www.apa.org/psycinfo/	Ciências Comportamentais e Saúde Mental
WEB OF SCIENCE	http://apps.webofknowledge.com	Transdisciplinar (Ciências, ciências sociais, artes e humanidades)
CINAHL	www.ebscohost.com/cinahl/	Enfermagem e Saúde
HINARI	http://www.who.int/hinari/en/	Literatura Biomédica e Saúde
INASP	www.inasp.info	Biblioteca Digital para Países em Desenvolvimento
eIFL	http://www.eifl.net/	Biblioteca Digital para Países em Desenvolvimento
SPORTSDISCUS	http://www.ebscohost.com	Ciências do Esporte

Para os mesmos descritores, essas bases de dados muitas vezes apresentam diferentes formas de indexação. Vocabulários de descritores controlados têm sido elaborados para indexação nas bases: MeSH (MEDLINE), DeCS (LILACS) e EMTREE (EMBASE), dentre outros. Além desses, os operadores booleanos AND (delimitador), OR (aditivo) e NOT (excludente), bem como os filtros disponibilizados nas bases de dados, também são utilizados dentre os descritores selecionados. Todas essas

estratégias, (descritores, operadores booleanos, filtros, sinônimos, variações de grafia, siglas e correlatos) são utilizados para aumento da sensibilidade e especificidade da busca (Santos et al., 2007).

Além dessas possibilidades, a busca manual é outra estratégia para assegurar acesso a maior quantidade de estudos. Portanto, o contato com os principais pesquisadores da área, bem como a leitura das referências dos estudos selecionados têm sido muito utilizados na literatura (Lefevbre et al., 2011).

Durante a estratégia de busca para revisões sistemáticas de estudos observacionais, algumas peculiaridades devem ser consideradas. Muitas dessas operações, principalmente os filtros das bases de dados, ainda não são muito bem estabelecidos para a realização da busca de artigos observacionais. Muitas vezes, mesmo após a utilização de todas as estratégias, a especificidade para encontrar evidências observacionais é muito baixa, oferecendo uma quantidade excessiva de artigos para a sessão de rastreamento de título e resumo, e dificultando a realização da síntese dos estudos.

Nesta revisão sistemática foram pesquisadas as seguintes bases de dados no dia 09/05/2013: *Medical Literature Analysis and Retrieval System Online* (Medline), *Excerpta Medica* (EMBASE), *Web of Science*, SPORTDiscus, PsycINFO, *Cumulative Index to Nursing and Allied Health Literature* (CINAHL), Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILLACS), e o *Sedentary Behavior Research Database* (SBRD).

A estratégia de busca foi elaborada pelo pesquisador principal (Leandro Fornias Machado de Rezende), e contou com a colaboração de um bibliotecário experiente. Os descritores utilizados na estratégia de busca seguiram o vocabulário específico de cada uma das bases de dados conforme o Quadro 2. Quando a base de dados não apresentou vocabulário específico, optou-se por utilizar os *MesH terms*, bem como as palavras-chave e sinônimos relacionados.

Quadro 2. Base de dados e seus respectivos vocabulários utilizados na revisão

Base de Dados	Vocabulário
MEDLINE	MesH terms
EMBASE	Emtree
LILLACS	DeCS
WEB OF SCIENCE	MesH terms
PSYCHINFO	APA
SPORTSDISCUS	MesH terms
CINAHL	Descritores CINAHL (idênticos MesH terms)

As palavras-chave usadas foram: **exposição** (*sedentary behavior, sedentary lifestyles, sitting time, television viewing, driving, screen-time, video game, and computer*); **desfechos primários** (*mortality, cardiovascular disease, cancer, type 2 diabetes mellitus*); e **desfechos secundários** (*accidental falls, frail elderly, obesity, metabolic syndrome, mental disorders, musculoskeletal diseases*). O Anexo I do artigo 1 apresenta os termos e as

combinações utilizados em cada uma das bases de dados, durante a busca das publicações.

Após a busca nas principais bases de dados, foi realizada uma busca manual para identificação dos artigos não contemplados. Foi realizado um rastreamento da lista de referências dos artigos completos incluídos no estudo e contactados mais de 400 membros, professores, pesquisadores e estudantes da *Sedentary Behavior Research Network*[4] (SBRN).

5.4. Seleção dos Artigos e Extração dos Dados

Segundo as recomendações gerais, após a busca nas bases de dados, deve ser realizada uma detalhada e transparente rastreamento com métodos para seleção dos artigos, a fim de reduzir erros e vieses (Higgins; Deeks, 2011). Para tal, a leitura de todos os títulos, resumos e, posteriormente, a leitura dos artigos na íntegra devem passar por uma avaliação independente/cegada, realizada por pelo menos dois avaliadores. Os avaliadores, preferencialmente, devem ter experiência com metodologia de pesquisa, bem como com a área de interesse da revisão. A opinião de um terceiro revisor deve ser solicitada nos casos em que não houver consenso (Pellizzon et al., 2003; O'Connor et al., 2011; Nobre; Bernardo, 2006).

[4] O SBRN é uma organização de pesquisadores e profissionais da saúde voltada para a pesquisa sobre os impactos do comportamento sedentário na saúde. Mais informações sobre essa rede estão disposíveis em: www.sedentarybehaviour.org.

Alguns *softwares* (Endnote®, Zotero®, etc) podem facilitar o processo de rastreamento, bem como a busca e armazenamento dos artigos de maneira mais rápida e eficaz. As referências podem ser buscadas e armazenadas no próprio programa. Além disso, artigos duplicados também podem ser removidos por meio desses *softwares*.

Quanto à extração dos dados, é importante que as informações mais relevantes sejam obtidas dos artigos primários com o auxílio de um instrumento de coleta ou formulário. Esse instrumento deve ser previamente elaborado baseado na pergunta da pesquisa (PICO ou PEOD), bem como outros elementos relevantes que deverão ser apresentados em uma tabela de resultados (Higgins; Deeks, 2011).

Também nessa etapa, é recomendado que mais de uma pessoa realize a extração dos dados para redução de erros e vieses introduzidos pelos autores. Para tal, é interessante fazer um piloto com uma amostra dos estudos para identificar limitações e padronizar as formas de coleta (Higgins; Deeks, 2011).

Na presente revisão sistemática, os artigos encontrados foram extraídos como textos das bases de dados e importados pelo Software de Administração de Referências EndNote Web® (Thomson Reuters, Carlsbad, CA, USA). Pelo EndNote Web®, os artigos receberam um único número de identificação e foram removidos em caso de duplicata.

Os títulos potencialmente elegíveis no rastreamento foram avaliados de forma independente/cegada por dois avaliadores (Leandro Fornias

Machado de Rezende e Juan Pablo Rey-Lopez), os quais examinaram todo o material empírico, discutindo as discrepâncias. A opinião de um terceiro revisor (Olinda do Carmo Luiz) foi solicitada nos casos em que não houve consenso.

A extração dos dados foi realizada em um banco de dados no *Excel for Windows* que continha todos os artigos selecionados durante a fase de rastreamento (Anexo II do artigo 1). Os dados foram extraídos de todos os artigos elegíveis por 2 revisores independentes (Leandro Fornias Machado de Rezende e Juan Pablo Rey-Lopez). As informações de autor, ano, país, grupo etário, número de participantes, tipo de população (população geral ou paciente), tipo de comportamento sedentário, instrumento de medida do comportamento sedentário, definição de sedentarismo, variáveis de confusão ajustadas e desfecho em saúde compuseram a primeira aproximação dos textos.

5.5. Avaliação da Qualidade dos Artigos

O viés mais importante em uma revisão sistemática de literatura está relacionado à seleção dos estudos, principalmente pela não inclusão ou não identificação de pesquisas importantes (Egger; Smith, 1998a). O principal motivo para isso são os estudos publicados em revistas não indexadas nas bases escolhidas pelos pesquisadores. Outro motivo é a tendência das revistas indexadas publicarem somente resultados positivos (Higgins; Green, 2011; Higgins; Altman, 2011). Relato de estudos em idiomas pouco

acessíveis aos pesquisadores pode ser outra explicação para a exclusão de artigos importantes (Higgins; Green, 2011; Higgins; Altman, 2011).

Outro aspecto é a qualidade da evidência dos artigos selecionados. Para tal, a validade interna e externa devem ser analisadas nos estudos elegíveis para a revisão sistemática (Shamliyan et al., 2012; Higgins; Altman, 2011).

As ferramentas para avaliação de viés e qualidade de evidências de ensaios clínicos são bem estabelecidas na literatura. Entretanto, a mesma atenção não tem sido dada aos estudos observacionais. Quase a metade das ferramentas criadas para os estudos observacionais não descrevem detalhadamente seus métodos de desenvolvimento, bem como os dados de validade e reprodutibilidade (Sanderson et al., 2007).

O GRADE (*Grades of Recommendation, Assessment, Development and Evaluation*) é um instrumento para avaliação da qualidade da evidência em quatro categorias: alta, moderada, baixa e muito baixa. Ele aborda a qualidade dos artigos não somente pela presença/ausência de viés, mas também pela imprecisão, inconsistência, e apresentação de resultados indiretos. Além dos ensaios clínicos, o GRADE pode ser aplicado em revisões sistemáticas de estudos observacionais (Guyatt et al., 2011a; 2011b; Shanliyam et al., 2012).

Nesta revisão sistemática, a aplicação do método de avaliação da qualidade pelo GRADE teve como destaque os seguintes itens: delineamento do estudo, presença de viés, imprecisão dos resultados,

evidência indireta, heterogeneidade, magnitude de efeito, relação dose-resposta e controle de variáveis de confusão.

A avaliação da qualidade da evidência foi realizada por meio de dois avaliadores independentes (Leandro Fórnias Machado de Rezende e Juan Pablo Rey-Lopez) e discutida em uma reunião de consenso. A avaliação da qualidade da evidência teve início pelo delineamento do estudo. Estudos observacionais começam com baixa qualidade de evidência (2 pontos), enquanto ensaios clínicos com alta qualidade (4 pontos). Como esta revisão sistemática incluiu somente estudos observacionais, todos os estudos tiveram a avaliação iniciada com baixa qualidade de evidência. A partir de então, os estudos perdiam pontos com base na presença dos seguintes tópicos: risco de viés (baixo risco, -1 ponto, ou alto risco, -2 pontos), imprecisão (baixa, -1 ponto, ou alta, -2 pontos), inconsistência (baixa, -1 ponto, ou alta, -2 pontos), evidência indireta ou *surrogate outcome* (-1 ponto ou -2 pontos). Entretanto, os estudos ganhavam pontos quando apresentavam: alta magnitude de efeito (RR 2 - 5 ou 0.5 – 0.2) (+ 1 ponto ou +2 pontos), ajuste adequado das variáveis de confusão (+1 ponto) e presença de relação dose-resposta (+1 ponto). Finalmente, os artigos foram categorizados em alta (4 pontos), moderada (3 pontos), baixa (2 pontos) e muito baixa (1 ponto) qualidade de evidência.

5.6. Síntese Qualitativa ou Quantitativa dos Dados

A partir do momento em que são buscados e rastreados todos os estudos localizados que respondem a pergunta da pesquisa, seus resultados devem ser sintetizados quantitativamente, caso sejam homogêneos, por meio de uma meta-análise, ou qualitativamente, por meio de uma síntese narrativa (Egger et al., 2001a; Higgins; Thompson, 2002).

É importante ressaltar as limitações das sínteses quantitativas – meta-análises – nas revisões sistemáticas de estudos observacionais. Matthias Egger e Davey George Smith afirmam que "existe a possibilidade de que uma meta-análise oriuda de estudos observacionais produza resultados muito precisos, mas igualmente espúrios" (Egger; Smith, 1998b, p.140) Sendo assim, a combinação estatística de dados não deve ser um componente importante de revisões de estudos observacionais, mas sim uma análise cuidadosa das possíveis fontes de heterogeneidade entre os estudos. Nesse tipo de revisão, a medida de efeito da meta-análise poderá apresentar um resultado diferente do real devido à heterogeneidade das pesquisas, às variáveis de confusão ou aos vieses entre os estudos (Egger; Smith, 1998b; Egger et al., 2001a; Higgins et al., 2002).

5.7. Aspectos Éticos

O projeto foi aprovado pelo Comitê de Ética em Pesquisa da Faculdade de Medicina da Universidade de São Paulo (CAPPesq) (Protocolo 027/13).

5.8. Financiamento da Pesquisa

O estudo recebeu apoio financeiro pela Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP; Protocolo nº 2012/07314-8). Este financiamento foi importante para a aquisição de material permanente (microcomputador e componentes e impressora a laser), serviços de terceiros e aquisição de *software*.

6. RESULTADOS

Os resultados deste trabalho foram a base do artigo *Sedentary Behavior and Health Outcomes among Older Adults: a Systematic Review* (Anexo 1) submetido à revista *BMC Public Health*. As atividades de pesquisa do mestrado permitiram ainda a elaboração de mais dois artigos:

- *Sedentary behaviour on health outcomes: an overview of systematic reviews* (Anexo 2), uma revisão de revisões sistemáticas sobre comportamento sedentário e desfechos em saúde, para as quais foi identificada a necessidade de uma revisão sistemática sobre idosos. O artigo foi submetido ao periódico *PLoSONE* no dia 02/10/2013 e se encontra em avaliação pelos editores.
- *Effect of Physical Inactivity on Major Non-Communicable Diseases and Life Expectancy in Brazil* (Anexo 3), idealizado a partir da leitura de artigos durante o período de mestrado. Para elaboração desse artigo, foi possível realizar um intercâmbio com pesquisadores renomados de outras instituições: Victor Matsudo (Centro de Estudos do Laboratório de Aptidão Física de São Caetano do Sul) e I-Min Lee (*Harvard Medical School*). O artigo foi aceito para publicação no periódico *Journal of Physical Activity and Health*.

Abaixo será realizada uma síntese das evidências de associação entre o comportamento sedentário e desfechos de saúde em idosos acima

de 60 anos de idade. Maiores detalhes dos resultados dessa revisão sistemática estão apresentados no artigo disponível no anexo 1.

6.1. Comportamento Sedentário e Desfechos na Saúde de Idosos

6.1.1. Mortalidade

Quatro estudos de coorte prospectiva (Campbell et al., 2013; Martinez-Gomez et al., 2013; Pavey et al., 2012; León-Muñoz et al., 2013), classificados como baixa (Campbell et al., 2013), moderada (Martinez-Gomez et al., 2013), e alta qualidade de evidência (Pavey et al., 2012; León-Muñoz et al., 2013), investigaram a relação entre comportamento e mortalidade (mortalidade por todas as causas, cardiovasculares, câncer colorretal, outras causas) em idosos.

O estudo de Martinez-Gomez et al. mostrou que os indivíduos que passaram menos de 8 horas/dia sentados tiveram um menor risco de mortalidade por todas as causa (HR 0,70; IC 95% 0,60 - 0,82), quando comparado ao seus pares mais sedentários. Além disso, os indivíduos que eram fisicamente ativos (>150 min/sem) e menos sedentários (<8 horas/dia sentados) apresentaram um menor risco de mortalidade por todas as (HR 0,44; IC 95% 0,36 - 0,52) do que aqueles que eram inativos e mais sedentários (Martinez-Gomez et al., 2013).

Da mesma forma, Pavey et al. encontraram uma relação dose-resposta entre o tempo sentado e a mortalidade por todas as causas em

idosos. Indivíduos que passavam de 8-11 horas/dia sentados (HR 1,35; IC 95% 1,09 – 1,66) e mais de 11 horas/dia sentados (HR 1,52; IC 95% 1,17 – 1,98) apresentaram maior risco de mortalidade por todas as causa do que aqueles menos sedentários. Para cada hora/dia gasto sentado, houve um aumento de 3 % (HR 1,03; IC 95% 1,01 - 1,05) no risco de mortalidade por todas as causas. Além disso, o risco de mortalidade por todas as causas de indivíduos que eram fisicamente inativos (menos de 150 min/sem) e passavam de 8-11 e 11 horas/dia sentado aumentou em 31 % (HR 1,31; IC 95% 1,07 - 1,61) e 47% (HR 1,47; IC 95% 1,15 - 1,93), respectivamente (Pavey et al., 2012).

Em León-Munoz e colaboradores, os indivíduos foram classificados como consistentemente sedentários (>mediana em 2001 e 2003), recém-sedentários (<mediana em 2001 e >mediana em 2003), ex-sedentários (>mediana em 2001 e <mediana em 2003) e consistentemente não sedentários (<mediana em 2001 e <mediana em 2003. Eles encontraram que, quando comparados ao grupo consistentemente sedentários, indivíduos recém-sedentários (HR 0,91; IC 95% CI 0,76 – 1,10), ex-sedentários (HR 0,86; IC 95% CI 0,70 – 1,05), e consistentemente sedentários (HR 0,75; IC 95% CI 0,62 – 0,90), tiveram uma proteção contra mortalidade por todas as causas (León-Muñoz et al., 2013).

Examinando uma população sobrevivente de câncer colorretal, Campbell e colaboradores identificaram indivíduos que permaneciam mais de 6 horas por dia sentados no tempo de lazer (pré-diagnóstico do câncer de cólon) apresentaram um risco aumentado de mortalidade por todas as

causas (RR 1,36; IC 95% 1,10 - 1,68) e mortalidade por outras causas (não cardiovascular e câncer colorretal) (RR, 1,48; IC 95% 1,05 - 2,08). Pós-diagnóstico de câncer de cólon, o tempo sentado (> 6 horas/dia) esteve associado com um risco de mortalidade por todas as causas (RR 1,27; IC 95% 0,99 - 1,64) e mortalidade específica por câncer colorretal (RR 1,62; IC 95 % 1,07 - 2,44) (Campbell et al., 2013).

6.1.2. Síndrome Metabólica

Três estudos transversais (Gardiner et al., 2011; Bankoski et al., 2011; Gao et al., 2007), classificados com muito baixa (Gardiner et al., 2011; Bankoski et al., 2011) e moderada qualidade de evidência (Gao et al., 2007) investigaram a relação entre comportamento sedentário e síndrome metabólica em idosos.

Gardiner et al., mostraram que os indivíduos que passam a maior parte do tempo sentado (quartil superior igual a >3 horas/dia) tiveram um aumento no risco de ter síndrome metabólica (homens: OR 1,57; IC 95 % 1,02 - 2,41 e mulheres: OR 1,56 IC; 95 % 1,09 - 2,24), quando comparados com os seus pares menos sedentários (quartil inferior igual a <1,14 hora/dia). No mesmo estudo, as mulheres que assistiam mais televisão (quartil superior) tiveram um aumento de 42% no risco de síndrome metabólica (OR 1,42; IC 95 % 1,01 - 2,01), quando comparados com aqueles que assistiam menos televisão por dia (quartil inferior) (Gardiner et al., 2011).

Corroborando com esses achados, Gao et al. mostraram que indivíduos que assistiam mais televisão (>7 horas/dia) tinham um risco aumentado (OR 2,2 IC 95% CI 1,1 - 4,2) de ter a síndrome metabólica, quando comparados com aqueles que assistiam <1 hora/dia. Em uma relação dose-resposta, para cada hora de televisão/dia, houve um aumento de 19% (OR 1,19; IC 95 % 1,1 - 1,3; p de tendência 0,002) no risco de apresentar síndrome metabólica (Gao et al., 2007).

Em Bankoski et al., maior percentagem do tempo gasto em comportamentos sedentário aumentou o risco de ter síndrome metabólica (apenas quartil 2 vs 1 quartil; as horas/dia de cada quartil não foi reportado nesse estudo; OR 1,58; IC 95% 1,03 - 2,24), enquanto as quebras no tempo sedentário ao longo do dia aumentaram a proteção contra a síndrome metabólica (apenas quartil 2 vs quartil 1; OR 1,53; IC 95% 1,05 - 2,23) (Bankoski et al., 2011).

6.1.3. Fatores de Risco Cardiometabólicos

Seis estudos transversais (Gardiner et al., 2011; Stamatakis et al., 2012; Hamer et al., 2012a, 2012b; Gao et al., 2007; Gennuso et al., 2013), classificados com muito baixa (Gardiner et al., 2011; Stamatakis et al., 2012; Hamer et al., 2012a, 2012b) e moderada qualidade de evidência (Gao et al., 2007; Gennuso et al., 2013), investiaram a relação entre comportamento sedentário e fatores de risco cardiometabólicos em idosos.

6.1.3.1. Triglicerídeos

A probabilidade de ter níveis altos de triglicérides foi maior em homens (OR 1,61; IC 95% 1,01 - 2,58) e mulheres (OR 1,66; IC 95% 1,14 - 2,41) que estavam no quartil mais elevado de tempo sentado total (Gardiner et al., 2011). Entretanto, nos estudos de Gao et al. e Gennuso et al. a associação entre o tempo gasto em comportamento sedentário e triglicérides elevados não foi estatisticamente significante (Gao et al., 2007; Gennuso et al., 2013).

6.1.3.2. Colesterol HDL

Gao et al encontraram que maior tempo gasto vendo televisão esteve associado com HDL baixo (OR 2,5; IC 95% 1,0 - 5,9; p<0,05) (Gao et al., 2007). No estudo de Gardiner et al., as mulheres no quartil mais elevado de tempo de televisão e os homens no quartil mais elevado de tempo sentado total, apresentaram um OR para HDL baixo de 1,64 (IC 95% 1,06 - 2,54) e 1,78 (IC 95% 1,05 - 3,02), respectivamente, quando comparado com seus pares do quartil mais baixo (Gardiner et al., 2011). No entanto, em Gennuso et al. não foi encontrada uma associação entre o tempo gasto em comportamentos sedentários e o HDL baixo (p =0,29) (Gennuso et al., 2013).

6.1.3.3. Pressão Arterial

Quando comparado com o quartil mais baixo do tempo sentado total, o OR de pressão arterial elevada no no terceiro quartil foi de 1,50 (IC 95%

1,03 - 2,19) (Gardiner et al., 2011). No estudo de Gao et al., maior tempo assistindo televisão esteve associado com a pressão arterial elevada (OR 2,5; IC 95% 1,0 - 6,0; p< 0,05) (Gao et al., 2007). No entanto, Gennuso et al. não encontrou uma relação entre o tempo gasto em comportamentos sedentário e pressão arterial sistólica (p= 0,09) e pressão arterial diastólica (p= 0,32) (Gennuso et al., 2013).

6.1.3.4. Glicose Plasmática, Hb1Ac e Intolerância à Glicose

Gennuso et al. mostraram que tempo assistindo televisão e tempo sedentário estiveram associados com a glicose plasmática elevada (p = 0,04) (Gennuso et al., 2013). No estudo de Gardiner et al., essa relação foi observada apenas em mulheres (OR 1,45; IC 95% 1,01 - 2,09; p< 0,05) (Gardiner et al., 2011). No entanto, nos estudos de Gao et al. e Stamatakis et al. não foram encontradas relações entre tempo de televisão e a glicose de jejum e o Hb1Ac (Gao et al., 2007; Stamatakis et al., 2012).

6.1.3.5. Colesterol Total e Razão de Colesterol (Total/HDL)

Gao et al demonstraram que a maior tempo de televisão esteve associado com uma alta razão de colesterol (total/HDL) (OR 2,0; IC 95% 1,1 - 3,7; p<0,05) (Gao et al., 2007). No estudo de Stamatakis et al., o comportamento sedentário no lazer (β 0,018; IC 95% 0,005 - 0,032), tempo de televisão (β 0,021; IC 95% 0,002 - 0,040) e o comportamento sedentário avaliado objetivamente por acelerometria (β 0,060; IC 95% 0,000 - 0,121) estiveram associados com a razão de colesterol (total/HDL) (Stamatakis et

al., 2012). No entanto, Gennuso et al. não encontraram umas associação entre o tempo gasto no comportamento sedentário e colesterol total (p= 0,50) (Gennuso et al., 2013).

6.1.3.6. Outros Biomarcadores Cardiometabólicos

Nos estudos conduzidos por Hamer e colaboradores, a associação entre o tempo de sedentarismo medido objetivamente por acelerometria e a gordura no pericárdio e calcificação da artéria coronária não foi observada após o ajuste pela prática de atividade física moderada a vigorosa (Hamer et al., 2012a; Hamer et al., 2012b). Por outro lado, Gennuso et al. encontraram uma associação entre as horas em comportamento sedentário e a proteína C-reativa (p< 0,01) (Gennuso et al., 2013).

6.1.4. Circunferência da Cintura, Relação Cintura-Quadril e Obesidade Abdominal

Seis estudos transversais (Gardiner et al., 2011; Lynch et al., 2011; Stamatakis et al., 2012; Gomez-Cabello et al., 2012; Gao et al., 2007; Gennuso et al., 2013) classificados com muito baixa (Gardiner et al., 2011; Lynch et al., 2011; Stamatakis et al., 2012; Gomez-Cabello et al., 2012) e moderada qualidade de evidência (Gao et al., 2007; Gennuso et al., 2013) investigaram a relação entre o comportamento sedentário e a circunferência da cintura, obesidade e a relação cintura-quadril em idosos.

Gardiner et al. e Gomez- Cabello et al. encontraram que o tempo sentado aumenta o risco de obesidade abdominal em 80% (OR 1,8; IC 95% 1,20 - 2,64) em ambos os sexos e 81% em mulheres (OR 1,81; IC 95% 1,21 - 2,70) (Gardiner et al., 2011; Gomez-Cabello et al., 2012).

No estudo de Stamatakis et al., o tempo de televisão (β 0,416; IC 95% 0,275 - 0,558) e o comportamento sedentário de lazer (β 0,234; IC 95% 0,129 - 0,339) estiveram associados com a maiores medidas da circunferência da cintura (Stamatakis et al., 2012). Gao et al. mostraram que maior tempo assistindo televisão esteve associado com alta relação cintura-quadril (OR 3,9; IC 95% 1,08 - 8,4; p< 0,01) (Gao et al., 2007). Em Gennuso et al. o tempo gasto em comportamentos sedentários medidos objetivamente por acelerometria estiveram associados com uma alta circunferência de cintura (p< 0,01) (Gennuso et al., 2013). Em uma população sobrevivente de câncer colorretal, o tempo de sedentarismo não apresentou relação com a circunferência da cintura (Lynch et al., 2011).

6.1.5. Excesso de Peso e Obesidade

Seis estudos transversais (Stamatakis et al., 2012; Frank et al., 2010; Gomez-Cabello et al., 2012a, 2012b; Gao et al., 2007; Inoue et al., 2012; Gennuso et al., 2013) com muito baixa (Stamatakis et al., 2012; Frank et al., 2010; Gomez-Cabello et al., 2012a, 2012b) e moderada qualidade de evidência (Gao et al., 2007; Inoue et al., 2012; Gennuso et al., 2013)

investigaram a relação entre comportamento sedentário e o excesso de peso/obesidade em idosos.

Gomez- Cabello et al., encontraram que indivíduos que ficavam sentado mais de 4 horas/dia tinham maior probalidade de apresentar excesso de peso (OR 1,7; IC 95% 1,06 - 2,82) e obesidade (OR 2,7; IC 95% 1,62 - 4,66) (Gomez-Cabello et al., 2012a). Em um estudo similar, Gomez-Cabello e colaboradores mostraram que indivíduos que ficavam mais de 4 horas/dia sentados tem maior probabilidade de ter excesso de peso (OR 1,42; IC 95% 1,06 - 1,89) e excesso de gordura corporal em mulheres (OR 1,4; IC 95% 1,14 - 1,74) e risco de obesidade central em homens (OR 1,74; IC 95% 1,21 - 2,49) (Gomez-Cabello et al., 2012b).

Em Gennuso et al., indivíduos que permaneciam mais tempo em comportamento sedentário (medido objetivamente por acelerometria) tinham maior probabilidade de apresentar um IMC elevado (Gennuso et al., 2013). O comportamento sedentário de lazer também mostrou-se associado com o IMC (β 0,088; IC 95% 0,047 - 0,130) em um estudo conduzido por Stamatakis e colaboradores (Stamatakis et al., 2012).

No estudo de Inoue et al., quando comparados com a categoria de referência (assistir muita televisão e ser fisicamente inativo) o OR de excesso de peso/obesidade entre aqueles que assistiam muita televisão e eram fisicamente ativos foi de 0,93 (95% CI 0,65 - 1,34), para os que assistiam pouca televisão e eram inativos foi de 0,58 (IC 95 % 0,37 - 0,90) e o para o grupo que assistia pouca televisão e eram fisicamente inativos foi de 0,67 (IC 95 % 0,47 - 0,97) (Inoue et al., 2012).

Stamatakis et al. e Gao et al. mostraram que o tempo de TV está associado com o IMC (β 0,16; IC 95% 0,15 - 0,22 e OR 1,4; 95% 0,7-2,8, respectivamente) (Stamatakis et al., 2012; Gao et al., 2007).

No único estudo que avaliou o comportamento sedentário no transporte, Frank et al. mostraram que uma hora/dia ou mais sentado no carro não esteve associada com excesso de peso (OR 0,86; IC 95 % 0,51 - 1,22) e obesidade (OR 0,67; IC 95% 0,41 - 1,06) (Frank et al., 2010).

6.1.6. Saúde Mental (demência, transtorno cognitivo leve, bem-estar psicológico)

Três estudos transversais (Buman et al., 2010; Dogra et al., 2012; Geda et al., 2011), um caso-controle (Geda et al., 2012), e dois estudos de coorte prospectiva (Balboa-Castillo et al., 2011; Verghese et al., 2003), classificados como muito baixa (Buman et al., 2010; Geda et al., 2012) e baixa qualidade de evidência (Dogra et al., 2012; Geda et al., 2011; Balboa-Castillo et al., 2011; Verghese et al., 2012) investigaram a relação entre o comportamento sedentário e saúde mental de idosos (demência, comprometimento cognitivo leve e bem-estar psicológico).

Em Verghese et al., os indivíduos que frequentemente jogavam jogos de tabuleiro (HR 0,26; IC 95% 0,17 - 0,57), realizavam leitura (HR 0,65; IC 95% 0,43 - 0,97) tiveram uma proteção contra demência, quando comparados àqueles que realizavam essas atividades raramente (Verghese et al., 2003).

Por outro lado, o estudo de Buman et al. encontrou que o comportamento sedentário também esteve associado negativamente com o bem-estar psicossocial (β -0,03; IC 95% -0,05 - 0,01; p<0,001) (Buman et al., 2010). Além disso, Dogra e colaboradores verificaram que 4 horas ou mais de comportamento sedentário por dia não esteve associado com o envelhecimento psicologicamente bem sucedido (Dogra et al., 2012).

Com relação ao comprometimento cognitivo leve, indivíduos que frequentemente leem livros (OR 0,67; IC 95% 0,49 - 0,94), jogam jogos de tabuleiro (OR 0,65; IC 95% 0,47 - 0,90), realizam atividades de artesanato (OR 0,66; IC 95% 0,47 - 0,93), atividades de computador (0,50; IC 95% 0,36 - 0,71), e assistim à televisão (OR 0,48; IC 95% 0,27 - 0,86) tiveram uma proteção quando comparados àqueles que realizam essas atividades raramente (Verghese et al., 2003). De acordo com o estudo de Geda et al., indivíduos que realizavam exercícios físicos e o usavam o computador tiveram uma diminuição na probabilidade de ter um comprometimento cognitivo leve (OR 0,36 IC 95 % 0,20-0,68) quando comparados aos que não realizam essas atividades (Geda et al., 2012).

Por outro lado, Balboa-Castillo et al., encontraram que indivíduos no maior quartil de tempo sentado tinham maior probabilidade de ter um pior a saúde mental (β - 5.04; IC 95% 8.87 - -1.21; p = 0,009 tendência) quando comparados aos indivíduos do primeiro quartil (Balboa-Castillo et al., 2011).

6.1.7. Câncer

Apenas um estudo, com qualidade moderada de evidência, investigou a relação entre comportamento sedentário e câncer em idosos. O estudo de George et al. não encontrou associação entre o tempo assistindo televisão ou vídeos e o risco de câncer renal (George et al., 2011).

7. DISCUSSÃO

Está é a primeira revisão sistemática que avaliou a associação entre o comportamento sedentário e desfechos de saúde em idosos, considerando a avaliação da qualidade dos estudos incluídos. De forma semelhante aos resultados encontrados em adultos (Thorp et al., 2011; Grontved et al., 2011; Wilmot et al., 2011; Lynch et al., 2010; Proper et al., 2011), nossa revisão encontrou evidências observacionais da associação entre o comportamento sedentário e aumento do risco de mortalidade por todas as causas em idosos. No entanto, nestes estudos, o comportamento sedentário foi medido através de questionários (tempo sentado), que têm mostrado validade moderada (Atkin et al., 2011). Estudos com qualidade moderada de evidência mostraram uma relação entre o comportamento sedentário e a síndrome metabólica, circunferência da cintura, e obesidade em idosos. Evidências sobre desfechos como saúde mental, células cancerosas renais foram insuficientes para conclusões.

No entanto, algumas atividades sedentárias como jogar jogos de tabuleiro, atividades de artesanato, leitura e uso de computador mostraram-se associadas com um menor risco de demência (Verghese et al., 2003).

Baseado na avaliação da qualidade da evidência realizada em nossa revisão sistemática, algumas sugestões para futuros estudos serão delineadas a seguir:

- Tipo de comportamento sedentário

  Novas pesquisas devem levar em consideração não apenas a quantidade de tempo gasto em comportamentos sedentários, mas o contexto social e cognitivo em que as atividades estão inseridas (Gabriel et al., 2012). Corroborando com os achados aqui apresentados, estudos têm mostrado que o uso de vídeo game e computador, apesar de classificados como comportamento sedentário pelos critérios de gasto energético e postura corporal (sentados), podem reduzir o risco de problemas de saúde mental em idosos (Anguera et al., 2013; Kuider et al., 2012; Primack et al., 2012).

- Delineamento

  Os estudos longitudinais com alta qualidade metodológica foram raros no presente levantamento. Eles são necessários para confirmação dos achados evidenciados nessa revisão, além da investigação sobre demais desfechos em saúde.

- Viés de Seleção

  Quase metade dos artigos analisados em nossa revisão (10 artigos: 42%), apresentaram possível viés de seleção por apresentar baixa taxa de resposta (*response rate*), participantes voluntários independentes e não institucionalizados e/ou sub-representação de alguns subgrupos populacionais (Gardiner et al., 2011; Lynch et al., 2011; George et al., 2011; Stamatakis et al., 2012; Frank et al., 2009;

Ara et al., 2012; Buman et al., 2010; Hamer et al., 2012a, 2012b; Inoue et al., 2012; Geda et al., 2011; Verghese et al., 2003).

- Viés de informação

  Até o momento, o uso de acelerômetros é o método mais confiável e válido para avaliar o comportamento sedentário, embora alguns dispositivos não sejam capazes de distinguir a postura dos indivíduos (sentado ou inclinado) (Wong et al., 2011). Em estudos com idosos, 5 dias de uso acelerômetro parece ser suficiente para avaliar o padrão de comportamento sedentário (Hart et al., 2011), entretanto, além da frequência semanal de uso, futuros estudos devem especificar claramente os critérios estabelecidos para o tempo sem utilizão do acelerômetro (Masse et al., 2005) e pontos de corte mais precisos (<150 counts/min) (Kozey-Keadle et al., 2011) a fim de evitar possíveis erros de classificação. Na nossa revisão, os estudos utilizaram pelo menos 7 dias de acelerometria, com um tempo de utilização sem acelerômetro estabelecido em 60 minutos sem a identificação de counts, e com o critério de comportamento sedentário ≤100 countrs/min (Lynch et al., 2011; Stamatakis et al., 2012; Buman et al., 2010; Inoue et al., 2012; Gennuso et al., 2013) ou ≤199 counts/min (Hamer et al., 2012a, 2012b).

  Em relação às medidas subjetivas, apesar de apresentar uma validade baixa a moderada, essas permitem a avaliação da dimensão contextual das atividades sedentárias (Atkin et al., 2011). Na presente

revisão, o viés de informação atribuível ao uso de questionários foi encontrado em 19 artigos (83%) (Gardiner et al., 2011; Lynch et al., 2011; George et al., 2011; Frank et al., 2010; Gomez-Cabello et al., 2012a, 2012b; Buman et al., 2010; Hamer et al., 2012a, 2012b, Inoue et al., 2012; Dogra et al., 2012; Geda et al., 2011, 2012; Balboa-Castillo et al., 2011; Campbell et al., 2013; Martinez-Gomez et al., 2013; Pavey et al., 2012; León-Muñoz et al., 2013; Verghese et al., 2003). Nesse sentido, sugere-se que futuros estudos utilizem métodos objetivos emergentes (por exemplo, a combinação de dados de localização geográfica combinados com os sinais de acelerometria em celulares) que foram desenvolvidos a fim de obter medidas precisas e com significado contextual dos padrões de comportamento sedentário (Atkin et al., 2011).

- Imprecisão

  Para reduzir o erro aleatório, futuros estudos epidemiológicos, especialmente com desenhos longitudinais, devem usar um tamanho de amostra adequado para analisar as possíveis relações do comportamento sedentário com desfechos em saúde. Na presente revisão, 14 estudos (58%) apresentaram resultados imprecisos (Gardiner et al., 2011; Lynch et al., 2011; George et al., 2011; Frank et al., 2010; Gomez-Cabello et al., 2012a, 2012b; Hamer et al., 2012b; Bankoski et al., 2011; Gao et al., 2007; Inoue et al., 2012; Dogra et al.,

2012; Gennuso et al., 2013; Geda et al., 2012; Balboa-Castillo et al., 2011).

- Inconsistência

  A análise de subgrupo devem ser realizados e relatadas em estudos futuros a fim de avaliar a consistência dos resultados. Na revisão, apenas um artigo permitiu avaliar a consistência dos resultados entre os subgrupos (Gardiner et al., 2011).

- Desfechos indiretos (*surrogates outcomes*)

  Na atual revisão, a utilização de desfechos indiretos esteve presente em 17 artigos (71%) (Gardiner et al., 2011; Lynch et al., 2011; Stamatakis et al., 2012; Frank et al., 2010; Gomez-Cabello et al., 2012a, 2012b, Buman et al., 2010; Hamer et al., 2012a, 2012b; Bankoski et al., 2011; Gao et al., 2007; Gennuso et al., 2013; Geda et al., 2011a, 2012). É importante ressaltar que as conclusões obtidas com desfechos indiretos só permitem uma melhor compreensão da fisiologia do comportamento sedentário. No entanto, os estudos não devem considerar estes desfechos indiretos como sinônimo de desfechos considerados *endpoints* (ex: mortalidade, doença cardiovascular) (Proper et al., 2011).

- Variáveis de Confusão

  Apesar de todos os estudos incluídos na nossa revisão incluírem a atividade física moderada a vigorosa como covariável, não deve-se descartar a possível presença de confusão residual, uma vez que, na maioria das vezes, essas variáveis foram medidas através de questionário (Andrade et al., 2012). Além disso, o estado de saúde deve ser medido e incluído como covariável em futuros estudos, especialmente em estudos de idosos (Andrade et al., 2012). Embora a maioria dos artigos tenham recebido ponto adicional na avaliação da qualidade no item “ajuste por possíveis variáveis de confusão” (Gardiner et al., 2011; Lynch et al., 2011; George et al., 2011; Stamatakis et al., 2012; Frank et al., 2010; Buman et al., 2010; Hamer et al., 2012a, 2012b; Bankoski et al., 2011; Gao et al., 2007; Inoue et al., 2012; Gennuso et al., 2013; Geda et al., 2011; Balboa-Castillo et al., 2011; Campbell et al., 2013; Martinez-Gomez et al., 2013; Pavey et al., 2012; León-Muñoz et al., 2013; Verghese et al., 2003), apenas 3 estudos incluíram estado de saúde no modelo (Gardiner et al., 2011; Pavey et al., 2012; León-Muñoz et al., 2013)

- Dose-resposta

  Apesar do comportamento sedentário ser uma variável fundamentalmente contínua, a maioria dos estudos avaliaram essa variável de maneira ordinal ou dicotômica. Essa categorização apresenta diversas limitações (Dinero et al., 1996; Altman et al., 2006)

como: a) perda de informação; b) indivíduos próximos aos pontos de corte definidos pelas categorias são considerados muito diferentes, quando na verdade são semelhantes; c) perda de poder estatístico e estimativa imprecisa; d) impossibilidade de analisar relações lineares. No entanto, caso futuros estudos ainda optem por categorizar essa variável, sugere-se a utilização de pequenos intervalos, com grupos mais homogêneos, que permitam a observação de um gradiente dose-resposta entre o comportamento sedentário e os desfechos em saúde. Na presente revisão, somente em 5 artigos foi possível analisar uma relação dose-resposta (Gao et al., 2007; Gennuso et al., 2013; Balboa-Castillo et al., 2011; Pavey et al., 2012; León-Muñoz et al., 2013).

8. CONSIDERAÇÕES FINAIS

As evidências científicas atuais são claras quanto aos efeitos deletérios da inatividade física e do comportamento sedentário na saúde das populações. Em nosso estudo encontramos que 3-5% das principais doenças crônicas (diabetes tipo 2, doenças coronarianas, câncer de mama e cólon) no Brazil são atribuíveis à inatividade física (Anexo C – Artigo 3). Além disso, 5,31% dos óbitos ocorridos em 2008 (53.673 mortes), foram atribuídos à inatividade física. Em outras palavras, se inatividade física foram eliminadas, a expectativa de vida dos brasileiros aumentaria em 0,34 anos. É importante ressaltar que essas estimativas estão baseadas em indivíduos que não faziam nenhuma atividade física em nenhum domínio, e para evitar essas doenças e mortes calculadas, bastaria a inclusão de qualquer atividade física na rotina. Obviamente que, se o cálculo fosse baseado na recomendação semanal de atividade física (150 minutos), as doenças e mortes atribuíveis à inatividade física seriam muito mais expressivas. Esses dados mostram o impacto da inatividade física nos doenças crônicas não transmissíveis e mortes no Brasil, corroborando com dados internacionais.

Entranto, o Brasil e o mundo também devem estar atentos quanto as evidências emergentes das relações do comportamento sedentário com a população. É importante ressaltar que as evidências da associação entre o comportamento sedentário e desfechos em saúde é um fenômeno

complexo, dependente do tipo de comportamento sedentário e faixas etárias estudadas investigadas.

Nossa overview de revisões sistemáticas (Anexo B - Artigo 2), encontrou que em crianças e adolescentes, existe uma forte evidência de associação entre o comportamento sedentário (baseado no tempo de TV e de tela) e obesidade. Além disso, encontramos uma evidência moderada de associação com a pressão arterial, colesterol total, auto-estima, problemas de comportamento social, a aptidão física e o desempenho acadêmico (com base no tempo de TV e tempo de tela).

Em adultos, encontramos uma forte evidência de associação entre o comportamento sedentário e mortalidade por todas as causas, doenças cardiovasculares fatais e não fatais (baseado no tempo de TV, tela e tempo sentado), diabetes 2 (baseado no tempo de TV e de tela) e síndrome metabólica (baseado no tempo de TV, tempo de tela, tempo sentado e tempo em comportamento sedentário medido por acelerometria). Além disso, existe uma evidência moderada de associação com a incidência de câncer de ovário (tempo sentado), cólon (tempo de TV) e endometrial (sentado fora o trabalho e tempo sentado total) e diabetes tipo 2 (tempo sentado).

Em idosos, nossa revisão sistemática (Anexo A - Artigo 1) encontrou evidências de que maior tempo gasto em comportamento sedentário (medido majoritariamente pelo tempo sentado) está associado com o aumento no risco de mortalidade por todas as causas, síndrome metabólica e obesidade.

Por conseguinte, políticas de promoção de atividade física no Brasil no Mundo devem criar ambientes favoráveis à saúde, infra-estrutura e programas que, através de ações intersetoriais e departamentais, garantam o engajamento de toda a população a um estilo de ativo. Entendendo-se por estilo de vida ativo, uma rotina equilibrada entre atividades diárias que incluam atividades físicas (leve, moderadas e vigorosas) e comportamento sedentário, tanto no lazer quanto no trabalho, em um local fixo ou deslocando-se, viajando ou estando em casa. Finalmente, esses programas e políticas devem pensar a atividade física e o comportamento sedentário como fenômenos complexo e multidimensionais, permeado de valores, ações e relações sociais, e não somente em atividades que envolvem o gasto energético, entendendo por estilo de vida ativo não somente a prática de atividade física no lazer ou exercícios físicos.

Ainda é necessário investir em políticas que incentivem a prática de atividade física e redução do comportamento sedentário em todos os domínios, através da ação intersetorial envolvendo prioritariamente as áreas de saúde, educação, esporte, meio ambiente, segurança, transporte e comunicação social, garantindo a participação da sociedade na definição do escopo e desenho dessas políticas.

ANEXO A

ARTIGO 1

Sedentary Behavior and Health Outcomes among Older Adults:

A Systematic Review

CARTA DE ACEITE

Authors: Leandro FM Rezende, Juan Pablo Rey-Lopez, Victor KR Matsudo and Olinda C Luiz

Title : Sedentary Behavior and Health Outcomes among Older Adults: a Systematic Review

Journal: BMC Public Health

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Peer review of your manuscript (above) is now complete and we are delighted to accept the manuscript for publication in BMC Public Health.

Before publication, our production team needs to check the format of your manuscript, to ensure that it conforms to the standards of the journal. They will get in touch with you shortly to request any necessary changes or to confirm that none are needed.

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Best wishes,

Mr. Proel Vargas

on behalf of Dr. Alessandra Buja

Sedentary Behavior and Health Outcomes among Older Adults: a Systematic Review

Leandro Fornias Machado de Rezende – lerezende@usp.br
University of São Paulo School of Medicine – Av. Dr Arnaldo, 455 – São Paulo-SP, Brazil
Center of Studies and Physical Fitness Laboratory from São Caetano do Sul (CELAFISCS), Rua Heloisa Pamplona, 269 - Bairro Fundação - São Caetano do Sul – SP

Juan Pablo Rey-Lopez - jprey@unizar.es
University of São Paulo School of Medicine – Av. Dr Arnaldo, 455 – São Paulo-SP, Brazil
University of Zaragoza - Calle Pedro Cerbuna, 12, 50009 Zaragoza, Espanha

Victor Keihan Rodrigues Matsudo – matsudo@celafiscs.org.br
Center of Studies and Physical Fitness Laboratory from São Caetano do Sul (CELAFISCS), Rua Heloisa Pamplona, 269 - Bairro Fundação - São Caetano do Sul – SP

Olinda do Carmo Luiz – olinda@usp.br
University of São Paulo School of Medicine – Av. Dr Arnaldo, 455 – São Paulo-SP, Brazil

Correspondence to Leandro Fornias Machado de Rezende, Rua Taipas 77, ap. 22, São Caetano do Sul, SP, Brazil, CEP 09560-200. Telephone number: + 55 11 3593-9793. Fax number: + 55 114427-8120. E-mail: lerezende@usp.br

ABSTRACT

Background: In the last decade, sedentary behavior has emerged as a new risk factor for health. The elderly spend most of their awake time in sedentary activities. Despite this high exposure, the impact of this sedentary behavior on the health of this population has not yet been reviewed.

Purpose We systematically reviewed evidence for associations between sedentary behavior and multiple health outcomes in adults over 60 years of age.

Methods We searched the Medline, Embase, Web of Science, SPORTDiscus, PsycINFO, CINAHL, LILLACS, and Sedentary Research Database for observational studies published up to May 2013. Additionally, we contacted members of the Sedentary Behaviour Research Network to identify articles that were potentially eligible. After inclusion, the methodological quality of the evidence was assessed in each study.

Results We included 24 eligible articles in our systematic review, of which only 2 (8%) provided high-quality evidence. Greater sedentary time was related to an increased risk of all-cause mortality in the older adults. Some studies with a moderate quality of evidence indicated a relationship between sedentary behavior and metabolic syndrome, waist circumference, and overweightness/obesity. The findings for other outcomes such as mental health, renal cancer cells, and falls remain insufficient to draw conclusions.

Conclusion This systematic review supports the relationship between sedentary behavior and mortality in older adults. Additional studies with high methodological quality are still needed to develop informed guidelines for addressing sedentary behavior in older adults.

Keywords: sedentary lifestyle, sitting time, television, risk factors, aged, health status, mortality.

INTRODUCTION

Globally, the older adult population has increased substantially, and it is estimated to reach approximately 22% of the world's population by 2050.[1,2] The risk of non-communicable diseases and disability increases with age, providing a challenge for health and social care resources.[3] The World Health Organization has created many recommendations for behavior change to reduce the burden of non-communicable diseases and disabilities among the elderly.[4] It is well established that physical activity plays a key role in the prevention of such diseases due to its close relationship with many of the chronic diseases and disabilities that largely affect the elderly, such as cardiovascular disease, cancer, type 2 diabetes, accidental falls, obesity, metabolic syndrome, mental disorders, and musculoskeletal diseases.[5,6]

However, in the last decade, sedentary behavior has emerged as a new risk factor for health.[7-9] Sedentary behaviors are characterized by any waking activity that requires an energy expenditure ranging from 1.0 to 1.5 basal metabolic rate and a sitting or reclining posture.[10] Typical sedentary behaviors are television viewing, computer use, and sitting time.[10] Epidemiological studies on different age groups show that a considerable amount of a human's waking hours are spent in sedentary activities, creating a new public health challenge that must be tackled.[11,12] The scientific study of sedentary behavior has become popular in recent years. In fact, several systematic reviews of sedentary behaviors and health outcomes among children, adolescents,[13-15] and adults[11,16-19] have recently been published. However, insights from these systematic reviews are limited for several reasons. Firstly, some of these systematic reviews did not evaluate the quality of evidence of

the reviewed articles.[17,16] Secondly, some reviews included subjects with a wide age range (i.e., >18 years).[16,17] Therefore, it is currently assumed that the deleterious health effects attributed to sedentary behaviors are similar among both adults (>18 years) and the elderly (>60 years). However, it has been observed that some cardiovascular risk factors (i.e., smoking, obesity, and consumption of alcohol) are less predictive of mortality in a large sample of Scandinavians aged 75 years or older.[20]

Furthermore, compared with other age groups, older adults are the most sedentary. Findings from studies in the US and Europe reported that objectively measured sedentary time was higher in those who were older than 50 years[12] and 65 years,[21] respectively. In addition, it has been reported that adults older than 60 years spend approximately 80% of their awake time in sedentary activities which represents 8 to 12 hours per day.[12,21,22] Similarly, Hallal et al. conducted a global assessment in more than 60 countries and found that the elderly had the highest prevalence of reporting a minimum of 4 hours of sitting time daily.[23] Despite this high exposure in the elderly, the health effects of sedentary behavior in this population have not yet been reviewed. Due to this knowledge gap, we systematically reviewed evidence to look for associations between sedentary behavior and multiple health outcomes in adults over 60 years of age.

METHODS

Identification and Selection of the Literature

In May 2013, we searched the following databases: Medline, *Excerpta Medica* (EMBASE), Web of Science, SPORTDiscus, PsycINFO, Cumulative Index to

Nursing and Allied Health Literature (CINAHL), *Literatura Latino-Americana e do Caribe em Ciências da Saúde* (LILLACS), and the Sedentary Behavior Research Database (SBRD).

The key-words used were as follows: exposure (sedentary behavior, sedentary lifestyles, sitting time, television viewing, driving, screen-time, video game, and computer); primary outcome (mortality, cardiovascular disease, cancer, type 2 diabetes mellitus); and secondary outcome (accidental falls, frail elderly, obesity, metabolic syndrome, mental disorders, musculoskeletal diseases). Further information regarding the search strategy is included in Supplementary File 1. According to the purpose of this systematic review, observational studies (cross-sectional, case-control, or cohort) involving older adults (all participants >60 years), with no restriction of language or date, were selected in the screening step.

In addition, we contacted the Sedentary Behaviour Research Network (SBRN) members in July 2013 to request references related to sedentary behavior in older adults. The SBRN is a non-profit organization focused on the scientific network of sedentary behavior and health outcomes. Additional information about the SBRN can be found elsewhere (http://www.sedentarybehaviour.org/).

The studies retrieved were imported into the EndNote Web® reference management software to remove any duplicates. Initially, titles and abstracts were screened by two independent reviewers (LFMR and JPRL). Relevant articles were selected for a full read of the article. Disagreements between the two reviewers were settled by a third reviewer. In addition, the reference lists of the relevant articles were reviewed to detect additional articles that were not identified in the previous search strategy.

Studies were excluded if they met the following criteria: 1) Included adults <60 years of age; 2) did not include physical activity as a covariate; or 3) presented only a descriptive analysis of sedentary behavior.

Data Extraction and Quality Assessment

The data from all of the eligible articles were extracted independently by two reviewers (LFMR and JPRL). The extracted data included the following information: author(s), year, country, age group, number of participants, type of population (general or patient), type of sedentary behavior, type of measurement tool, sedentary definition, adjusted confounders, and outcome (Table 1).

The quality assessment was performed by two independent reviewers (LFMR, JPRL) and discussed during a consensus meeting. The quality of articles was assessed using the *Grades of Recommendation, Assessment, Development and Evaluation* (GRADE) tool (Table 2). Briefly, the GRADE quality assessment tool begins with the design of the study. Studies with an observational design start with a low quality (2 points). The studies then lose points based on the presence of the following topics: risk of bias (-1 or -2 points), imprecision (-1 or -2 points), inconsistency (-1 or -2 points), and indirectness (surrogate outcome) (-1 or -2 points). However, studies gain points if the following criteria are met: a high magnitude of effect (RR 2 - 5 or 0.5 – 0.2) (+ 1 or 2 points), adequate confounding adjustment (+1 point), and a dose-response relationship (+1 point). Finally, the quality of the articles is categorized as follows: high (4 points), moderate (3 points), low (2 points), or very low (1 point). Further information about GRADE has been published elsewhere.[24]

RESULTS

Search and Selection

The search included 10874 potentially relevant articles (1301 from Medline, 5190 from EMBASE, 2803 from Web of Science, 184 from CINAHL, 160 from Lillacs, 154 from SportsDiscus, 936 from PsychInfo, and 146 from Sedentary Behavior Research Database). Fourteen additional records were selected from the articles suggested by the SBRN members (Figure 1).

After removing duplicate records, a total of 9768 articles remained. After screening titles and abstracts, 56 full papers were read in their entirety. In addition, 2 articles were found in the reference list of these full papers (an additional 787 titles were screened). Of the 58 articles, only 23 met the inclusion criteria and were included in the review. The complete list of included and excluded articles is presented in the Supplementary file 2.

Methodological Quality Assessment

Table 1 presents the quality assessment of the 23 articles included in the review. Of the 23 articles included, 16 (70%) were cross-sectional studies,[25-40] 1 (4%) was a case-control study,[41] and 6 (26%) were prospective cohort studies.[42-47] Concerning quality of the evidence, 12 (52%) were evaluated as very low,[25,26,29-36,38,42] 5 (22%) as low,[39,41,43,44,48] 4 (17%) as moderate,[28,37,40,45] and 2 (9%) as high quality evidence.[46,47]

Risk of selection bias was identified in 9 articles (39%),[25,28,29,31-34,37,42,47] and information bias due to self-reported instruments was found in 20 articles (83%).[25-27,31-34,37,38,40-47] Indirectness (surrogate outcomes) was used in 16

articles (70%),[25-37,39-41] imprecise results were presented in 14 (61%) articles,[25,26,27,30-32,34-39,41,42] and an inconsistent[25] result among subgroups was found in 1 (4%) article. Most of the articles (n=20 – 87%) received an additional point for the adjustment of potential confounders.[25-29,32-39,41-47] Eleven (48%) studies gained a point for magnitude of effect[30,36,398-42,44-47] and 5 (22%) for considering a dose-response relationship.[36,39,42,45,46] Further details concerning the quality assessment of each article are presented in the Supplementary file 3.

Sedentary Behavior—Health Outcomes

Mortality

Four prospective cohort studies,[43-46] classified as low,[43] moderate[44] and high quality,[45,46] investigated the relationship between sedentary behavior and mortality (all-cause, cardiovascular, colorectal cancer, other causes).

Martinez-Gomez et al.'s[44] study showed that individuals who spent less than 8 hours sitting/day had a lower risk of all-cause mortality (HR = 0.70, 95% CI: 0.60 to 0.82) when compared with their sedentary peers. In addition, individuals who were physically active and less sedentary (<8 hours/day of sitting) showed a lower risk of all cause-mortality (HR 0.44; 95% CI: 0.36 to 0.52) than those who were inactive and sedentary.

Similarly, Pavey et al.[45] found a dose-response relationship between sitting time and all-cause mortality. Individuals who spent 8-11 hours/day (HR 1.35; 95% CI 1.09 – 1.66) and more than 11 hours/day sitting (HR 1.52; 95% CI 1.17 – 1.98) presented a higher risk of all-cause mortality than those who spent less than 8

hours/day sitting. For each hour/day spent sitting, there was an increase of 3% (HR 1.03; CI 95% 1.01-1.05) in the risk of all-cause mortality. Moreover, the risk of all-cause mortality of individuals who were physically inactive (less than 150 minutes/week) and spent 8-11 or more than 11 hours/day sitting increased by 31% (HR 1.31, 95% CI 1.07 to 1.61) and 47% (HR 1.47, CI 1.15 to 1.93), respectively.

In León-Munoz et al.,[46] individuals were classified as consistently sedentary (>median in 2001 and 2003), newly sedentary (<median in 2001 and >median in 2003), formerly sedentary (>median in 2001 and <median in 2003), and consistently nonsedentary (<median in 2001 and 2003). They found that when compared with the consistently sedentary group, subjects newly sedentary (HR 0.91; 95% CI 0.76 - 1.10), formerly sedentary (0.86; 95% CI 0.70 - 1.05), or consistently non-sedentary (0.75; 95% CI 0.62 - 0.90) were protective against all-cause mortality.

Examining a colorectal cancer survivor population, Campbell et al.[43] identified that more than 6 hours per day of pre-diagnosis leisure sitting time, when compared with fewer than 3 hours per day, was associated with a higher risk of all-cause mortality (RR, 1.36; 95% CI, 1.10 to 1.68) and mortality from all other causes (not cardiovascular and colorectal cancer) (RR, 1.48; 95% CI 1.05-2.08). Post-diagnosis (colon cancer) sitting time (>6 hours) was associated with a higher risk of all-cause mortality (RR, 1.27; 95% CI, 0.99 to 1.64) and colorectal cancer-specific mortality (RR, 1.62; 95% CI, 1.07-2.44).

Metabolic syndrome

Three cross-sectional studies,[25,35,36] classified as very low[25,35] and moderate[36] quality, investigated the relationship between sedentary behavior and metabolic syndrome.

Gardiner et al.,[25] showed that individuals who spent most of their time sitting (highest quartile, >3 hours/day) had an increased odds of having metabolic syndrome (men: OR 1.57; CI 95% 1.02 – 2.41 and women: OR 1.56; CI 95% 1.09 – 2.24) when compared with their less sedentary peers (lowest quartile, <1.14 hours/day). In the same study, women who watched more television (highest quartile) increased their risk of metabolic syndrome by 42% (OR 1.42; CI 95% 1.01 – 2.01) when compared with those who watched less television per day (lowest quartile).

In the same sense, Gao et al.[36] showed that individuals in the highest quartile (>7 hours/day) of television watching/day, when compared with those in the lowest quartile (<1 hours/day), had an increased odds (OR 2.2, 95% CI 1.1–4.2) of having metabolic syndrome. In a dose-response relationship, for each hour of television watching/day, there was an increase of 19% in the odds (95% CI 1.1–1.3; p for trend 0.002) of having metabolic syndrome.

Bankoski et al.[35] found that a greater percentage of the time spent in sedentary behavior increased the risk of having metabolic syndrome (only quartile 2 vs. quartile 1, the hours/day of each quartile was not reported; OR 1.58; 95% CI 1.03 - 2.24), whereas breaks in sedentary time throughout the day protected against metabolic syndrome (only quartile 2 vs. quartile 1; OR 1.53; 95% CI 1.05 - 2.23).

Cardiometabolic biomarkers

Six cross-sectional studies,[25,28,33,34,36,39] classified as of very low[25,28,33,34] and of moderate quality,[36,39] investigated the relationship between sedentary behavior and independent cardiometabolic biomarkers.

Triglycerides

The likelihood of having high triglycerides was higher in men (Odds Ratio (OR) 1.61; 95% CI 1.01-2.58) and women (OR 1.66; 95% CI 1.14-2.41) who were in the highest quartile of overall sitting time.[25] However, Gao et al.[36] and Gennuso et al.[39] showed that the association between time spent in sedentary behavior and high triglycerides was not statistically significant.

HDL cholesterol

Gao et al.,[36] found that greater time spent viewing television was associated with low HDL cholesterol (2.5; 95% CI 1.0-5.9; $p<0.05$). In a study by Gardiner et al.,[25] women in the highest quartile of television viewing and men in the highest quartile of overall sitting time presented an OR for low HDL cholesterol of 1.64 (95% CI 1.06-2.54) and 1.78 (95% CI 1.05-3.02), when compared with the lowest quartile, respectively. However, Gennuso et al.[39] found that the relationship between time spent in sedentary behavior and low HDL cholesterol was not statistically significant ($p=0.29$).

Blood pressure

When compared with the lowest quartile of overall sitting time, the OR for high blood pressure in the third quartile was 1.50 (95% CI 1.03-2.19).[25] In Gao et al.'s[36] study, greater time viewing television was associated with high blood pressure (2.5; 95% CI 1.0-6.0; $p<0.05$). However, Gennuso et al.[39] found that the relationship between time spent in sedentary behavior and systolic blood pressure ($p=0.09$) and diastolic blood pressure ($p=0.32$) was not statistically significant.

Plasma Glucose/ Hb1Ac/ Glucose intolerance

Gennuso et al.[39] demonstrated that greater television viewing and sedentary time was associated with higher plasma glucose ($p=0.04$). In Gardiner et al.'s[25] study, this relationship was observed only in women (1.45; 95% CI 1.01-2.09; $p<0.05$). However, Gao et al.[36] and Stamatakis et al.[28] found that the relationship between television viewing and high fasting glucose and Hb1Ac was not statistically significant.

Cholesterol ratio and total

Gao et al.[36] demonstrated that greater time in television viewing was associated with a high total-to-HDL cholesterol ratio (OR 2.0; 95% CI 1.1-3.7; $p<0.05$). In Stamatakis et al.'s[28] study, self-reported total leisure-time sedentary behavior (β 0.018; 95% CI 0.005-0.032), television viewing (β 0.021; 95% CI 0.002-0.040), and objectively assessed sedentary behavior (β 0.060; 95% CI 0.000-0.121) were associated with cholesterol ratio. However, Gennuso et al.[39] found that the

relationship between time spent in sedentary behavior and total cholesterol was not statistically significant (p=0.50).

Other Cardiometabolic biomarkers

The association between objectively measured sedentary time and pericardial fat[33] and coronary artery calcification[34] was not observed after adjusting for moderate to vigorous physical activity. Gennuso et al.[39] found a positive association between sedentary hours and C-reactive protein (p<0.01).

Waist Circumference/Waist-to-Hip Ratio/Abdominal Obesity

Six cross-sectional studies,[25,26,28,30,36,39] classified as being of very low[25,26,28,30] and of moderate[36,39] quality, investigated the relationship between sedentary behavior and waist circumference/waist-to-hip/abdominal obesity. Gardiner et al.[25] and Gomez-Cabello et al.[30] found that sitting time increased the risk of abdominal obesity by 80% (OR 1.8; 95% CI 1.20-2.64) in both sexes and 81% in women (OR 1.81; 95% CI 1.21-2.70).

In Stamatakis et al.'s[28] study, television time (β 0.416; 95% CI 0.275 - 0.558) and total self-reported leisure-time sedentary behavior (β 0.234; 95% CI 0.129 - 0.339) were positively related to waist circumference. Gao et al.[36] found that greater time in television viewing was associated with high waist-to-hip ratio (3.9; 95% CI 1.08 - 8.4; p<0.01). Gennuso et al.[39] found that more time spent in objectively measured sedentary behavior was associated with a high waist circumference (p<0.01). In a colorectal cancer survivor population,[26] sedentary time was not associated with waist circumference.

Overweight/Obesity

Six cross-sectional studies,[28-31,36,37,39] classified as being of very low[28-31,37] and of moderate[36,39] quality, investigated the relationship between sedentary behavior and overweight/obesity.

Gomez-Cabello et al.[30] demonstrated that sitting more than 4 hours/day increased the risk of overweight (OR 1.7; 95% CI 1.06-2.82) and obesity (OR 2.7; 95% CI 1.62-4.66). In a similar study, Gomez-Cabello et al.[31] showed that being seated more than 4 hours/day increased the risk of overweight/obesity (OR 1.42; 95% CI 1.06-1.89) and overfat (1.4 OR; 95% CI 1.14-1.74) in women and the risk of central obesity (OR 1.74; 95% CI 1.21 – 2.49) in men.

Gennuso et al.[39] found that more time spent in objectively measured sedentary behavior was associated with higher BMI ($p<0.01$). In Stamatakis et al.'s[28] study, self-reported leisure-time sedentary behavior (β 0.088; 95% CI 0.047 - 0.130) was associated with BMI.

Inoue et al.[37] found that when compared with the reference category (high television(TV)/insufficient moderate to vigorous physical activity (MVPA)), the adjusted ORs (95% CI) of overweight/obesity were 0.93 (95% CI 0.65-1.34) for high TV/sufficient MVPA, 0.58 (95% CI 0.37-0.90) for low TV/insufficient MVPA, and 0.67 (95% CI 0.47-0.97) for low TV/sufficient MVPA. Stamatakis et al.[28] also showed that TV time (β 0.159; 95% CI 0.104-0.215) was positively associated with BMI. However, only Gao et al.[36] found that greater time of television viewing was statistically significantly association with BMI (OR 1.4; 95% 0.7-2.8).

In the only study that evaluated sedentary behavior in transport, Frank et al.[29] showed that ≥1 hour/day sitting in cars was not associated with overweight (0.86 OR. 95% CI 0.51-1.22) or obesity (0.67 OR; 95 CI% 0.41-1.06).

Mental Health (Dementia, mild cognitive impairment, psychological well-being)

Three cross-sectional studies,[32,38,40] one case-control,[41] and two prospective cohort studies,[42,47] classified as very low[32,41] and low quality[38,40,42,47] investigated the relationship between sedentary behavior and mental health (dementia, mild cognitive impairment, and psychological well-being).

In Verghese et al.'s[47] study, individuals who frequently played board games (HR 0.26; 95% CI 0.17-0.57) and read (HR 0.65; 95% CI 0.43-0.97) were less likely to develop dementia.

Buman et al.[32] demonstrated that sedentary time was negatively associated with psychosocial well-being (β -0.03; 95% CI -0.05 - -0.01); $p < 0.001$. However, Dogra et al.[38] found that 4 hours or more of sedentary behavior per day was not associated with psychologically successful aging.

With regards to mild-cognitive impairment (MCI), reading books (OR 0.67; 95% CI 0.49-0.94), playing board games (OR 0.65; 95% CI 0.47-0.90), craft activities (OR 0.66; 95% CI 0.47-0.93), computer activities (OR 0.50; 95% CI 0.36-0.71), and watching television (OR 0.48; 95% CI 0.27-0.86) were significantly associated with a decreased odds of having MCI.[40] According to Geda et al.'s[41] study, physical exercise and computer use were associated with a decreased likelihood of having MCI (OR 0.36; CI 95% 0.20-0.68).

However, Balboa-Castillo et al.[42] found that the highest quartile of sitting time was negatively associated with mental health (β-5.04; 95% CI -8.87- -1.21); p trend=0.009.

Cancer

Only one study, with moderate quality, found no association between time watching television or videos and renal cell carcinoma.[27]

DISCUSSION

To the best of our knowledge, this is the first systematic review to examine the association between sedentary behavior and health outcomes in older people while considering the methodological quality of the reviewed studies. Similar to previous reviews in adults,[16-19,48] the present review shows observational evidence that greater time spent in sedentary activities is related to an increase risk of all-cause mortality in the elderly. However, in these studies, sedentary behavior was measured through self-reported questionnaires (e.g., hours/day of sitting time), which have moderate criterion validity.[49] Studies with a moderate quality of evidence showed a relationship between sedentary behavior and metabolic syndrome, waist circumference, and overweight/obesity. The findings for other outcomes, such as mental health, renal cancer cells, and falls, remain insufficient to draw conclusions.

However, some sedentary activities (e.g., playing board games, craft activities, reading, computer use) were associated with a lower risk of dementia.[47] Thus, future studies should take into account not only the amount of time spent in sedentary behavior but the social and cognitive context in which the activities takes

place.[50] To illustrate this point, some studies have shown that video game and computer use, even though classified as sedentary by energy expenditure criteria, may reduce the risk of mental health disorders.[51-53]

Methodological Issues

To overcome the limitations of the observational studies available, future longitudinal studies with a high methodological quality are required. Moreover, the primary limitations found in the reviewed articles should be taken into account in future studies (Supplementary file 3). Based on these limitations, we offer several recommendations for future studies.

Selection Bias: In nearly half of the reviewed articles (10 articles: 42%), the following selection biases were found: a low response rate; the use of independent and non-institutionalized volunteer participants; and an underrepresentation of some population subgroups.[25,27,28,29,31-34,37,41,47]

Information bias: To date, the use of accelerometers is the most valid and reliable method for evaluating sedentary behavior, although some devices are not able to distinguish sitting and standing posture.[54] In studies of the elderly, 5 days of accelerometer use seems to be sufficient to evaluate the pattern of sedentary behavior.[55] When using accelerometers, future studies should clearly specify the criteria established for non-wear time[56] and use the most accurate sedentary cut-points (150 counts/min)[57] to avoid misclassification. In the current review, all studies used at least 7 days of accelerometry, with a non-wear time criteria of 60 minutes without counts and sedentary cut-points of <100 counts/minute[26,28,32,37,39] or <199 counts/minute.[33,34]

Although subjective measurements present a low to moderate reliability, they allow for the evaluation of the contextual dimension of the sedentary activities.[49] In the present review, information bias attributable to self-reported instruments was found in 19 articles (83%).[25-27,29-34,37,38,40-47]

In this sense, emergent objective methods (e.g., combination of geolocation data combined with acceleration signals in mobile phone) have been developed to obtain a precise and meaningful characteristic of the patterns of sedentary behavior.[49]

In addition, most of the studies in this review used different categorization criteria when measuring sedentary behavior.[43-46] This variation in categorization criteria could limit future synthesis of the evidence. We recommend that future studies on the elderly use existing categorizations of sedentary behavior.

Imprecision: To reduce random error, future epidemiological studies, especially with longitudinal designs, should use an adequate sample size. In the present review, 14 (58%) studies presented imprecise results.[25,26,27,29-31,34-39,41,42]

Inconsistency: Subgroup and heterogeneity analysis should be performed and reported in future studies to evaluate the consistency of the findings. In the current study, only one article presented the consistency of the findings between subgroups.[25]

Indirectness: In the current review, indirectness (surrogate outcomes) was present in 17 articles (71%).[25-37,39-41] Importantly, conclusions obtained with surrogate markers only allow a better understanding of the sedentary behavior physiology. However, researchers should not consider these surrogate markers as synonymous with the endpoint outcomes.[48]

Thus, endpoint outcomes (e.g., cardiovascular events, cancer and mortality) should be addressed in future studies.

Confounding adjustment: The confusion of effects (confounding) is a central issue in epidemiology. Although all of the studies in the present review included some covariates, such as moderate to vigorous physical activity, some residual confounding may be present.[59] Moreover, health status should be measured and included as a covariate, especially in studies of the elderly to avoid confounding.[59] Although most of the articles received better quality scores when they adjusted for potential confounders,[25-29,32-40,42-47] only 3 studies included health status as a covariate.[25,45,46] Future observational studies should include these important covariates in their statistical analysis.

Dose-response: Although sedentary behavior is a continuous variable, most of the studies categorized it as either an ordinal or a dummy variable. Such categorization could be an important limitation.[60,61] However, if future studies opt to categorize, they should use small intervals with more homogeneous groups that may allow for the observation of a dose-response gradient between sedentary behavior and health outcomes. In the present review, a dose-response was detected in 5 articles.[36,39,42,45,46]

CONCLUSION

This review confirms previous evidence of the relationship between sedentary behavior and all-cause mortality among adults. Due to the moderate quality of the studies, weak evidence exists regarding other health outcomes (metabolic syndrome, cardiometabolic biomarkers, obesity, and waist circumference). However, of note,

some sedentary activities (e.g., playing board games, craft activities, reading, and computer use) had a protective relationship with mental health status (dementia). Future studies should consider the main methodological limitations summarized in this review to improve the current state of the art. Finally, intervention trials that support the observational knowledge are needed to create informed guidelines for sedentary behavior in the elderly.

Abbreviations

EMBASE: *Excerpta Medica; CINAHL:* Cumulative Index to Nursing and Allied Health Literature (CINAHL), LILACS: *Literatura Latino-Americana e do Caribe em Ciências da Saúde*, SBRD:, and the Sedentary Behavior Research Database (SBRD). SBRN: Sedentary Behaviour Research Network, GRADE: Grades of Recommendation, Assessment, Development and Evaluation, HR: Hazard Ratio, RR: Relative Risk; OR: Odds Ratio, High Density Lipoprotein (HDL), MVPA: moderate to vigorous physical activity, TV: television, BMI: body mass index, MCI: mild-cognitive impairment.

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Authors' information

LFMR is a master's student in the Department of Preventive Medicine - University of São Paulo School of Medicine. JPRL is a post-doctoral student in the Department of Preventive Medicine - University of São Paulo School of Medicine. VKRM is a scientific coordinator of CELAFISCS, OCL is a scientific researcher in the Department of Preventive Medicine - University of São Paulo School of Medicine.

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Table 1: Characteristics of the included studies

Author	Year	Country	Population	Age		N	Sedentary Behavior			Adjustment	Outcome
				Range	Mean		Type	Measurement tool	Definition		
Gardiner et al.[25]	2011	Australia	General	≥60	69	1958	Television viewing and Overall Sitting time	Questionnaire	Quartile	age, education, alcohol consumption, smoking status, diet quality, self-rated health, physical activity, and hormone replacement therapy or estrogen use in women	Metabolic Syndrome, HDL, TG, abdominal obesity, glucose intolerance
Lynch et al.[26]	2011	USA	Cancer Survirors patiens	75.4 (7.3)		103	Sedentary Time	Accelerometer	<100 cpm	age, educational attainment, total energy intake, and moderate-to-vigorous intensity activity	Waist Circumference
George et al.[27]	2011	USA	General		63	289,512	Television viewing and Total sitting	Questionnaire	Television viewing (<1; 1-2; 3-4; 5-6; ≥7h/day) and Total sitting (<3; 3-4; 5-6; 7-8; ≥9h/day)	age, race, history of diabetes, smoking, alcohol intake, diet quality, energy intake, age at first live birth/parity, and recreational MVPA	Renal Cell Carcinoma
Stamatakis et al.[28]	2012	UK	General	≥60		2765 (649 with accelero meter)	Objectively-measured sedentary time, Total leisure-time sedentary behaviour, TV viewing time, and non-TV leisure-time sitting	Questionnaire and Accelerometer	Objectively-measured sedentary time (<100 cpm);	Age, sex, employment status, smoking, education, depression (GHQ score) alcohol consumption, fruit and vegetable consumption, cardiovascular medication (diabetes medication for Hb1Ac), frequency of unhealthy foods consumption, and self-reported MVPA	BMI, waist circumference, cholesterol ratio, and Hb1Ac
Frank L et al. [29]	2010	USA	General	≥65		1970	Time Traveling by car	Questionnaire	>1 hour/day	age, living alone, household income, car, ethnicity, education, gender, walkability, walking trip, and MVPA	Overweight and Obesity
Gomez-Cabello et al. [30]	2012	Spain	General	65-89	73.1 (5)	457	Sitting Time	Questionnaire	<4, >4 hours/day	Walking hours	Overweight and Obesity
Gomez-Cabello et al. [31]	2012	Spain	General	≥65		3136	Sitting time	Questionnaire	<4, >4 hours/day	Age and Walking time	Central obesity, overweight-obesity, overfat.

Buman et al. [32]	2010	USA	General	≥65	75.4	862	Sedentary Time	Accelerometer	<100 cpm	age, gender, race, education, senior housing resident status, current smoking status, site, marital status, neighborhood-level walkability, neighborhood-level income, and accelerometer wear time, and other activity threshold.	Physical health, psychosocial well-being
Hamer et al. [33]	2012	England	General		66 (5.6)	446	Sedentary Time	Accelerometer	<199 cpm	Age, sex, registered time, BMI, HDL, LDL, blood pressure, glycated hemoglobin, smoking, statins, and MVPA	Pericardial fat
Hamer et al. [34]	2012	Netherlands	General		66 (6)	443	Sedentary Time	Accelerometer	<199 com; Tertile	Age, sex, physical activity registered time, employment, statins use, systolic blood pressure, HDL, TG, BMI, Hb A1c	Coronary artery calcification
Bankoski et al.[35]	2011	USA	General	≥60		1,367	Sedentary Time	Accelerometer	Sedentary <100 cpm; Duration of sedentary time (hours), % of sedentary time of total wear time, average length of sedentary bout (min), intensity during sedentary time (counts), number of sedetary breaks.	Age, sex, ethnicity, education, alcohol intake, smoking, BMI, diabetes, heart disease and physical activity	Metabolic Syndrome
Gao et al.[36]	2007	USA (Puerto Rico, Dominican)	General	≥60		455	Television viewing	Questionnaire	quartile	age, sex, ethnicity, BMI, education, household arrangement, smoking, and current alcohol use, total energy intake, saturated fat intake, polyunsaturated fat intake, trans fat intake, fruit and vegetable intake, and physical activity score, and daily living score	Metabolic Syndrome

Inoue et al.[37]	2012 Japan	General	65 - 74		1806	Television viewing	Questionnaire	>median TV viewing (high), <mean TV viewing (low) - high TV/insufficient MVPA, high TV/sufficient MVPA, low TV/insufficient MVPA, and low TV/sufficient MVPA	sex, age, education, employment status, city of residence, smoking, drinking, and physical functioning	Overweight and Obesity
Dogra et al.[38]	2012 Canada	General	≥65		9,478	Sitting time	Questionnaire	<2, 2-4, 4 hours/day		Sucessful aging (Physical, Psychological and Sociological)
Gennuso et al.[39]	2013 USA	General	≥65		1, 914	Sedentary Time	Accelerometer	<100 com; quartiles	age, gender, ethinicity, education, income, marital status, alcohol consumption, current smoking status, cardiovascular disease, accelerometer wear time, BMI (except for weight, waist circumference, and BMI), and physical activity	Cardiometabolic risk factors (weight, BMI, waist circumference, systolic BP, diastololic BP, total cholesterol, HDL, HbA1C, CRP, Triglycerides, LDL, plasma glucose) and physical function
Geda et al[40]	2011 USA	General		70-89	1321	Reading books, reading magazines, craft activities, artistic activities, playing games, computer activities, watching television	Questionnaire	Once a month or less vs any other frequence	age, sex, education, depression, medical comorbidity, and physical exercise	Mild cognitive impairment
Geda et al[41]	2012 USA	General	70-93		926	Computer activities	Questionnaire	Computer use (yes or no)	age, sex, education, depression, medical comorbidity, and caloric intake.	Mild cognitive impairment
Balboa-Castillo et al[42]	2011 Spain	General	≥62	70.3 (5.6)	1097	Sitting hours	Questionnaire	Quartile	Age, sex, education, size of municipality of residence, smoking, alcohol consumption, coronary disease, stroke, cancer, chronic obstructive pulmonary disease, diabetes mellitus, arterial hypertension, physical activity, score in SF-36 in the previous measurement	Mental Health

Campbell et al[43]	2013 USA	Cancer Survirors	≥60	2262	Leisure-Time Spent Sitting (driving or sitting in a car, sitting on a bus, or sitting on a train; sitting and watching television; and sitting at home reading)	Questionnaire	<3, 3-6, ≥6 hours/day	age at diagnosis; sex; smoking status; body mass index; red meat intake; Surveillance, Epidemiology, and End Results (SEER) summary stage at diagnosis; recreational physical activity; and education	All-cause mortality, colorectal cancer-specific mortality, cardiovascular disease-specific mortality, mortality from all other causes
Martinez-Gomez et al[44]	2013 Spain	General	≥60	3,465	Sitting Time (eating, listening to the radio, watching television, reading, sewing, drinving and so on).	Questionnaire	<8h/day (yes or no)	age, sex, and educational attainment, occupational status, alcohol intake, former drinking, extreme sleep durations, BMI, waist circumference, systolic blood pressure, hypercholesterolemia status, coronary heart disease, stroke, diabetes mellitus, hip fracture, cancer, never smoking or quitting tobacco >15 years very/moderately physically active, healthy diet score > median in the cohort, sleeping 7 to 8h/d, interaction with friends daily.	All-cause mortality
Pavey et a.[45]	2012 Australia	General	76-81	6656	Sitting time	Questionnaire	0-4, 4-8, 8-11, ≥11 hours/day	age, education, marital status, area, smoking, alcohol consumption, BMI, physical activity, number of chronic conditions, self-reported health and assistance with daily tasks	All-cause mortality

León-Muñoz et al.[46]	2013	Spain	General	≥60	2635	Sitting time	Questionnaire	Quartile	sex, age, educational level, smoking, alcohol consumption, BMI, physical activity, chronic lung disease, ischemic heart disease, diabetes mellitus, osteomuscular disease, cancer, SF-36, limitations in mobility, and limitations in agility.	All-cause mortality
Verghese J et al[47]	2003	USA	General	≥75	469	Playing board games, reading, doing crossword puzzles, and writting	Questionnaire	Rare and Frequent (several times per week)	age, sex, educational level, presence or absence of medical illnesses, score on the Blessed Information–Memory–Concentration test, and participation or nonparticipation in other leisure activities including physical activities.	Dementia

Table 2: Quality of articles assessed using the Grades of Recommendation, Assessment, Development and Evaluation (GRADE)

Author	Year	Design	Bias	Imprecision	Indirectness	Heterogeneity	Magnitude of effect	Confounding Adjustment	Dose-response	Rating
Gardiner et al.[25]	2011	Cross-sectional	-1	-1	-1	-1	0	1	0	1
Lynch et al.[26]	2011	Cross-sectional	-1	-1	-1	0	0	1	0	1
George et al.[27]	2011	Cross-sectional	2	-1	-1	0	0	1	0	3
Stamatakis et al.[28]	2012	Cross-sectional	-1	0	-1	0	0	1	0	1
Frank et al.[29]	2010	Cross-sectional	-2	-1	-1	0	0	1	0	1
Gomez-Cabello et al.[30]	2012	Cross-sectional	-1	-1	-1	0	1	0	0	1
Gomez-Cabello et al.[31]	2012	Cross-sectional	-1	-1	-1	0	0	0	0	1
Buman et al.[32]	2010	Cross-sectional	-2	0	-1	0	0	1	0	1
Hamer et al.[33]	2012	Cross-sectional	-2	0	-1	0	0	1	0	1
Hamer et al.[34]	2012	Cross-sectional	-2	-1	-1	0	0	1	0	1
Bankoski et al.[35]	2011	Cross-sectional	0	-1	-1	0	0	1	0	1
Gao et al.[36]	2007	Cross-sectional	0	-1	-1	0	1	1	1	3
Inoue et al.[37]	2012	Cross-sectional	-2	-1	-1	0	0	1	0	1
Dogra et al.[38]	2012	Cross-sectional	-1	-1	0	0	1	1	0	2
Gennuso et al.[39]	2013	Cross-sectional	0	-1	-1	0	1	1	1	3
Geda et al.[40]	2011	Cross-sectional	-1	0	-1	0	1	1	0	2
Geda et al.[41]	2012	Case-Control	-1	-1	-1	0	1	0	0	1
Balboa-Castillo et al.[42]	2011	Prospective Cohort	-2	-1	0	0	1	1	1	2
Campbell et al.[43]	2013	Prospective Cohort	-1	0	0	0	0	1	0	2
Martinez-Gomez et al.[44]	2013	Prospective Cohort	-1	0	0	0	1	1	0	3
Pavey et al.[45]	2012	Prospective Cohort	-1	0	0	0	1	1	1	4
León-Muñoz et al.[46]	2013	Prospective Cohort	-1	0	0	0	1	1	1	4
Verghese et al.[47]	2003	Prospective Cohort	-2	0	0	0	1	1	0	2

SUPPLEMENTARY FILE 1

SEARCH STRATEGY

MEDLINE - 09/05/2013

(((((((mortality)) OR (cardiovascular disease)) OR (cancer)) OR (type 2 diabetes mellitus))) OR (((((((accidental falls)) OR (frail elderly)) OR (obesity)) OR (metabolic syndrome)) OR (mental disorders)) OR (musculoskeletal diseases)))) AND ((((((((((((sedentary behaviour)) OR (sedentary behaviours))) OR (((sedentary lifestyle)) OR (sedentary lifestyles))) OR (((television viewing)) OR (tv viewing))) OR (((tv watching)) OR (television watching))) OR (((video game)) OR (video games))) OR (sitting time)) OR (driving)) OR ("screen time")) OR (computer)) AND (((physical activity)) OR (physical inactivity))) Filter: "aged, 80 and over; aged

Medline Search Details

(((((("mortality"[Subheading] OR "mortality"[All Fields] OR "mortality"[MeSH Terms]) OR ("cardiovascular diseases"[MeSH Terms] OR ("cardiovascular"[All Fields] AND "diseases"[All Fields]) OR "cardiovascular diseases"[All Fields] OR ("cardiovascular"[All Fields] AND "disease"[All Fields]) OR "cardiovascular disease"[All Fields])) OR ("neoplasms"[MeSH Terms] OR "neoplasms"[All Fields] OR "cancer"[All Fields])) OR ("diabetes mellitus, type 2"[MeSH Terms] OR "type 2 diabetes mellitus"[All Fields])) OR ((((((("accidental falls"[MeSH Terms] OR ("accidental"[All Fields] AND "falls"[All Fields]) OR "accidental falls"[All Fields]) OR ("frail elderly"[MeSH Terms] OR ("frail"[All Fields] AND "elderly"[All Fields]) OR "frail elderly"[All Fields])) OR ("obesity"[MeSH Terms] OR "obesity"[All Fields])) OR (metabolic[All Fields] AND ("syndrome"[MeSH Terms] OR "syndrome"[All Fields]))) OR ("mental disorders"[MeSH Terms] OR ("mental"[All Fields] AND "disorders"[All Fields]) OR "mental disorders"[All Fields])) OR ("musculoskeletal diseases"[MeSH

Terms] OR ("musculoskeletal"[All Fields] AND "diseases"[All Fields]) OR "musculoskeletal diseases"[All Fields]))) AND ((((((((((sedentary[All Fields] AND ("behaviour"[All Fields] OR "behavior"[MeSH Terms] OR "behavior"[All Fields])) OR (sedentary[All Fields] AND ("behaviours"[All Fields] OR "behavior"[MeSH Terms] OR "behavior"[All Fields] OR "behaviors"[All Fields]))) OR (("sedentary lifestyle"[MeSH Terms] OR ("sedentary"[All Fields] AND "lifestyle"[All Fields]) OR "sedentary lifestyle"[All Fields]) OR ("sedentary lifestyle"[MeSH Terms] OR ("sedentary"[All Fields] AND "lifestyle"[All Fields]) OR "sedentary lifestyle"[All Fields] OR ("sedentary"[All Fields] AND "lifestyles"[All Fields]) OR "sedentary lifestyles"[All Fields]))) OR ((("television"[MeSH Terms] OR "television"[All Fields]) AND viewing[All Fields]) OR (tv[All Fields] AND viewing[All Fields]))) OR ((tv[All Fields] AND watching[All Fields]) OR (("television"[MeSH Terms] OR "television"[All Fields]) AND watching[All Fields]))) OR (("video games"[MeSH Terms] OR ("video"[All Fields] AND "games"[All Fields]) OR "video games"[All Fields] OR ("video"[All Fields] AND "game"[All Fields]) OR "video game"[All Fields]) OR ("video games"[MeSH Terms] OR ("video"[All Fields] AND "games"[All Fields]) OR "video games"[All Fields]))) OR (sitting[All Fields] AND ("time"[MeSH Terms] OR "time"[All Fields]))) OR ("automobile driving"[MeSH Terms] OR ("automobile"[All Fields] AND "driving"[All Fields]) OR "automobile driving"[All Fields] OR "driving"[All Fields])) OR "screen time"[All Fields]) OR ("computers"[MeSH Terms] OR "computers"[All Fields] OR "computer"[All Fields])) AND (("motor activity"[MeSH Terms] OR ("motor"[All Fields] AND "activity"[All Fields]) OR "motor activity"[All Fields] OR ("physical"[All Fields] AND "activity"[All Fields]) OR "physical activity"[All Fields]) OR (("physical examination"[MeSH Terms] OR ("physical"[All Fields] AND "examination"[All Fields]) OR "physical examination"[All Fields] OR "physical"[All Fields]) AND inactivity[All Fields]))) AND ("aged, 80 and over"[MeSH Terms] OR "aged"[MeSH Terms])

EMBASE - 09/05/2013

#1.26
#1.14 AND #1.25 AND [aged]/lim

#1.25
#1.15 OR #1.16 OR #1.17 OR #1.18 OR #1.19 OR #1.20 OR #1.21 OR #1.22 OR #1.23 OR #1.24

#1.24
'mortality'/exp OR mortality

#1.23
'musculoskeletal disease'/exp OR 'musculoskeletal disease'

#1.22
'mental disease'/exp OR 'mental disease'

#1.21
'metabolic syndrome x'/exp OR 'metabolic syndrome x'

#1.20
'obesity'/exp OR obesity

#1.19
'falling'/exp OR falling

#1.18
'frail elderly'/exp OR 'frail elderly'

#1.17
'non insulin dependent diabetes mellitus'/exp OR 'non insulin dependent diabetes mellitus'

#1.16
'neoplasm'/exp OR neoplasm

#1.15
'cardiovascular disease'/exp OR 'cardiovascular disease'

#1.14
#1.12 AND #1.13

#1.13
#1.2 OR #1.10 OR #1.11

#1.12
#1.1 OR #1.2 OR #1.3 OR #1.4 OR #1.5 OR #1.6 OR #1.7 OR #1.8 OR #1.9

#1.11
'physical inactivity'/exp OR 'physical inactivity'

#1.10
'physical activity'/exp OR 'physical activity'

#1.9
'video games'/exp OR 'video games'

#1.8
'computer'/exp OR computer

#1.7
'screen time'

#1.6
'car drive'/exp OR 'car drive'
#1.5
'television viewing'/exp OR 'television viewing'
#1.4
'sitting'/exp OR sitting
#1.3
sedentary AND ('behavior'/exp OR behavior)
#1.2
sedentary AND ('behaviour'/exp OR behaviour)
#1.1
'sedentary lifestyle'/exp OR 'sedentary lifestyle

LILLACS - 09/05/2013

Motor Activity OR Actividad Motora OR Atividade Motora OR Physical Activity OR Sedentary Lifestyle OR Estilo de Vida Sedentario OR Estilo de Vida Sedentário OR "Sitting Time" OR Sentado" OR "Sedentary Time" OR "Tempo Sentado" OR Tiempo Sentado" OR Television OR Televisión OR Televisão OR Automobile Driving OR Conducción de Automóvil OR Condução de Veículo OR Videogame OR Video Game OR Computer OR Computador; Filter: Aged

WEB OF SCIENCE - 09/05/2013

(((((("physical inactivity")) OR (physical activity))) AND ((((((((((((sedentary behavior)) OR (sedentary lifestyles)) OR ("sedentary time")) OR (sitting time)) OR (tv viewing)) OR (television viewing)) OR (tv watching)) OR (television watching)) OR (driving)) OR ("screen based")) OR (video game)) OR (computer)) OR ("screen time"))) AND Topic=(middle aged OR aged OR aged, 80 and over)

SPORTSDISCUS - 09/05/2013

Sedentary behavior OR sedentary behaviour OR sedentary lifestiles OR sedentary time OR “screen time” OR television viewers OR television viewing OR computer OR video games OR driving behavior AND physical activity OR physical inactivity OR sedentary behavior OR sedentary lifestyles OR sedentary behaviour AND older people OR aged OR elderly OR old age AND mortality OR cardiovascular disease OR cancer OR neoplasm OR type 2 diabetes OR diabetes OR obesity OR metabolic syndrome OR falls in old age OR frail elderly OR musculoskeletal system diseases OR mental disorders OR mental health

PSYCHINFO - 09/05/2013

Any Field: ((AnyField:(obesity) OR AnyField:(metabolic syndrome x) OR AnyField:(metabolic syndrome) OR AnyField:(accidental falls) OR AnyField:(frail) OR AnyField:(musculoskeletal disorders) OR AnyField:(mental disease) OR AnyField:(mental disorders)) OR (AnyField:(mortality) OR AnyField:(cardiovascular disease) OR AnyField:(type 2 diabetes mellitus) OR AnyField:(cancer) OR AnyField:(neoplasm))) *AND* Any Field: (((AnyField:(physical activity) OR AnyField:(physical inactivity) OR AnyField:(sedentary) OR AnyField:(sedentary behaviour) OR AnyField:(sedentary behaviour)) AND (AnyField:(sedentary) OR AnyField:(sedentary lifestyle) OR AnyField:(sitting) OR AnyField:(sedentary behavior) OR AnyField:(sedentary behaviour) OR AnyField:(driving behavior) OR AnyField:(television viewing) OR AnyField:("screen time") OR AnyField:(computer) OR AnyField:(video games))) AND (AnyField:(aged) OR AnyField:(older) OR AnyField:(elderly)))

CINAHL - 09/05/2013

Sedentary behavior OR sedentary behaviour OR sedentary lifestiles OR sedentary time OR “screen time” OR television viewers OR television viewing OR computer OR video games OR driving behavior AND physical activity OR physical inactivity OR sedentary behavior OR sedentary lifestyles OR sedentary behaviour AND older people OR aged OR elderly OR old age AND mortality OR cardiovascular disease OR cancer OR neoplasm OR type 2 diabetes OR diabetes OR obesity OR metabolic syndrome OR falls in old age OR frail elderly OR musculoskeletal system diseases OR mental disorders OR mental health

SUPPLEMENTARY FILE 2

Included Articles

25. Gardiner PA, Healy GN, Eakin EG, Clark BK, Dunstan DW, Shaw JE, Zimmet PZ, and Owen N. Associations between television viewing time and overall sitting time with the metabolic syndrome in older men and women: the Australian Diabetes, Obesity and Lifestyle study. JAGS. 2011;59(5):788-796

26. Lynch BM, Dunstan DW, Winkler E, Healy GN, Eakin E, and Owen N. Objectively assessed physical activity, sedentary time and waist circumference among prostate cancer survivors: findings from the National Health and Nutrition Examination Survey (2003-2006). Eur J Cancer Care. 2011;20:514-519.

27. George SM, Moore SC, Chow WH, Schatzkin A, Hollenbeck AR, and Matthews CE. A Prospective Analysis of Prolonged Sitting Time and Risk of Renal Cell Carcinoma Among 300,000 Older Adults. Ann Epidemiol 2011;21:787–790.

28. Stamatakis E, Davis M, Stathi A, and Hamer M. Associations between multiple indicators of objectively-measured and self-reported sedentary behaviour and cardiometabolic risk in older adults. Prev Med 2012;54:82-87.

29. Frank L, Keer J, Rosenberg D, and King A. Healthy Aging and Where You Live: Community Design Relationships With Physical Activity and Body Weight in Older Americans. J Phys Act Health. 2010;7(Suppl 1):S82-S90

30.Gomez-Cabello A, Vicente-Rodriguez G, Pindado M, Vila S, Casajús JA, Pradas de la Fuente F, and Ara I. Increased risk of Obesity and central obesity in sedentary postmenopausal Women. Nutr Hosp. 2012;27(3):865-870.

31.Gomez-Cabello A, Pedreto-Chamizo R, Olivares PR, Hernández_Perera R, Rodríguez-Marroyo JA, Mata E, Aznar S, Villa JG, Espino-Torón L, Gusi N, González-Gross, Casajús JA, Ara I, and Vicente-Rodríguez G. Sitting time increases the overweight and obesity risk independently of walking time in elderly people from Spain. Maturitas. 2012;73(4):337–343.

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33. Hamer M, Venuraju SM, Urbanova L, Lahiri A, and Steptoe A. Physical activity, sedentary time, and pericardial fat in healthy older adults. Obesity. 2012;20:2113–2117.

34. Hamer M, Venuraju SM, Lahiri A, Rossi A, and Steptoe A. Objectively assessed physical activity, sedentary time, and coronary artery calcification in healthy older adults. Artriolscler Thromb Vasc Biol 2012;32:500-505

35. Bankoski A, Harris TB, McClain JJ, Brychta RJ, Caserotti P, Chen KY, Berrigan D, Troiano RP, and Koster A. Sedentary Activity Associated With Metabolic Syndrome Independent of Physical Activity. Diabetes Care. 2011;34:497–503.

36. Gao X, Nelson ME, Tucker KL. Television viewing is associated with prevalence of metabolic syndrome in hispanic elders. Diabetes Care. 2007;30:694–700.

37. Inoue S, Sugiyama T, Takamiya T, Oka K, Owen N, and Shimomitsu T. Television Viewing Time is Associated with Overweight/Obesity Among Older Adults, Independent of Meeting Physical Activity and Health Guidelines. J Epidemiol 2012;22(1):50-56

38. Dogra S, Stathokostas L. Sedentary Behavior and Physical Activity Are Independent Predictors of Successful Aging in Middle-Aged and Older Adults. J Aging Res. 2012(2012);190654

39. Gennuso KP, Gangnon RE, Matthews CE, Thraen-Borowski KM, and Colbert LH. Sedentary Behavior, Physical Activity, and Markers of Health in Older Adults. Med. Sci. Sports Exerc. 2013;45(8):1493.

40. Geda YE, Topazian HM, Roberts LA, Roberts RO, Knopman DS, Pankratz VS, Christianson TJ, Boeve BF, Tangalos EG, Ivnik RJ, Petersen RC. Engaging in cognitive activities, aging, and mild cognitive impairment: a population based study. J Neuropsychiatry Clin Neurosci. 2011;23(2):149-154.

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42. Balboa-Castillo T, León-Munoz LM, Graciani A, Rodríguez-Artalejo F, Guallar-Castillón P. Longitudinal association of physical activity and sedentary behavior during leisure time with health-related quality of life in community-dwelling older adults. Health and Qual Life Outcomes 2011;27;9:47

43. Campbell PT, Patel AV, Newton CC, Jacobs EJ, and Gapstur SM. Associations of recreational physical activity and leisure time spent sitting with colorectal cancer survival. J Clin Oncol 2013;31(7):876-885

44. Martinez-Gomez D, Guallar-Castillón P, León-Munoz LM, López-Garcia E, and Rodríguez-Artalejo F. Combined impact of traditional and non-traditional health

behaviors on mortality: A national prospective cohort study in Spanish older adults. BMC Med 2013;22(11):47

45. Pavey TG, Peeters GG, and Brown WJ. Sitting-time and 9-year all-cause mortality in older women. Br J Sports Med. 2012;0:1–5

46. León-Muñoz LM, Martínez-Gómez D, Balboa-Castillo T, López-García E, Guallar-Castillón P, Rodríguez-Artalejo F. Continued Sedentariness, Change in Sitting Time, and Mortality in Older Adults. Med Sci Sports Exerc. 2013;45(8):1501-1507.

47. Verghese J, Lipton RB, Katz MJ, Hall CB, Derby CA, Kuslansky G, mabrose AF, Sliwinski M, and Buschke H. Leisure Activities and the Risk of Dementia in the Elderly. N Engl J Med. 2003;348(25):2508-2516.

Excluded Articles	**Reason**
Vallance JK, Eurich D, Marshall AL, Lavallee CM, and Johnson ST. Associations between sitting time and health-related quality of life among older men. Mental Health and Physical Activity. 2013;6(1):46-54	Age group
Lynch BM, Friedenreich CM, Winkler EA, Healy GN, Vallance JK, Eakin EG, Owen N. Associations of objectively assessed physical activity and sedentary time with biomarkers of breast cancer risk in postmenopausal women: findings from NHANES (2003-2006). Breast Cancer Res Treat. 2011;130(1):183-94.	Age group
Maeba K and Takenaka K. Factors affecting falls self-efficacy of home-bound elderly people. Nihon Ronen Igakkai Zasshi. 2010;47(4):323-8.	Other health outcome
Marcellini F, Giuli C, Papa R, Gagliardi C, Malavolta M, Mocchegiani E. BMI, life-style and psychological conditions in a sample of elderly italian men and women. J Nutr Health Aging. 2010;14(7):515-22.	Descriptive analysis
Kim MT, Juon HS, Hill MN, Post W, Kim KB. Cardiovascular disease risk factors in Korean American elderly. West J Nurs Res. 2001;23(3):269-82.	Did not include sedentary behavior
Intorre F, Maiani G, Cuzzolaro M, Simpson EE, Catasta G, Ciarapica D, Mauro B, Toti E, Zaccaria M, Coudray C, Corelli S, Palomba L, Polito A. Descriptive data on lifestyle, anthropometric status and mental health in Italian elderly people. J Nutr Health Aging. 2007;11(2):165-74.	Descriptive analysis
Lennartsson C, Silverstein M. Does engagement with life enhance survival of elderly people in Sweden? The role of social and leisure activities. J Gerontol B Psychol Sci Soc Sci. 2001;56(6):S335-42.	Did not include physical activity as a covariate
Herrera AP, Meeks TW, Dawes SE, Hernandez DM, Thompson WK, Sommerfeld DH, Allison MA, Jeste DV. Emotional and cognitive health correlates of leisure activities in older Latino and Caucasian women. Psychol Health Med. 2011;16(6):661-74	Did not include physical activity as a covariate
	Did not include

Fares D, Barbosa AR, Borgatto AF, Coqueiro Rda S, Fernandes MH. Factors associated with nutritional status of the elderly in two regions of Brazil. Rev Assoc Med Bras. 2012;58(4):434-41.	physical activity as a covariate
McDermott MM, Liu K, Ferrucci L, Tian L, Guralnik JM, Liao Y, Criqui MH. Greater sedentary hours and slower walking speed outside the home predict faster declines in functioning and adverse calf muscle changes in peripheral arterial disease. J Am Coll Cardiol. 2011;57(23):2356-64.	Age group
Dodge HH, Kita Y, Takechi H, Hayakawa T, Ganguli M, Ueshima H. Healthy cognitive aging and leisure activities among the oldest old in Japan: Takashima study. J Gerontol A Biol Sci Med Sci. 2008 Nov;63(11):1193-200.	Did not include physical activity as a covariate
Hirvensalo M, Rantanen T, Heikkinen E. Mobility difficulties and physical activity as predictors of mortality and loss of independence in the community-living older population. J Am Geriatr Soc. 2000;48(5):493-8.	Did not include sedentary behavior
Fox KR, Stathi A, McKenna J, Davis MG. Physical activity and mental well-being in older people participating in the Better Ageing Project. Eur J Appl Physiol. 2007 Jul;100(5):591-602	Did not include physical activity as a covariate
Gregg EW, Cauley JA, Seeley DG, Ensrud KE, Bauer DC. Physical activity and osteoporotic fracture risk in older women. Study of Osteoporotic Fractures Research Group. Ann Intern Med. 1998;129(2):81-8	Did not include physical activity as a covariate
Gierach GL, Chang SC, Brinton LA, Lacey JV Jr, Hollenbeck AR, Schatzkin A, Leitzmann MF.Physical activity, sedentary behavior, and endometrial cancer risk in the NIH-AARP Diet and Health Study. Int J Cancer. 2009;124(9):2139-47	Age group
Moore SA, Hallsworth K, Plötz T, Ford GA, Rochester L, Trenell MI. Physical activity, sedentary behaviour and metabolic control following stroke: a cross-sectional and longitudinal study. PLoS One. 2013;8(1):e55263.	Sedentary behavior as a outcome
Jürimäe J, Kums T, Jürimäe T. Plasma adiponectin concentration is associated with the average accelerometer daily steps counts in healthy elderly females. Eur J Appl Physiol. 2010;109(5):823-8.	Did not include physical activity as a covariate
Lucas M, Mekary R, Pan A, Mirzaei F, O'Reilly EJ, Willett WC, Koenen K, Okereke OI, Ascherio A. Relation between clinical depression risk and physical activity and time spent watching television in older women: a 10-year prospective follow-up study. Am J Epidemiol. 2011;174(9):1017-27	Age group
Chastin SF, Ferriolli E, Stephens NA, Fearon KC, Greig C. Relationship between sedentary behaviour, physical activity, muscle quality and body composition in healthy older adults. Age Ageing. 2012;41(1):111-4.	Research letter and other health outcome
Gill TM, Gahbauer EA, Murphy TE, Han L, Allore HG. Risk factors and precipitants of long-term disability in community mobility: a cohort study of older persons. Ann Intern Med. 2012 Jan 17;156(2):131-40.	Did not include sedentary behavior
Allison MA, Jensky NE, Marshall SJ, Bertoni AG, Cushman M. Sedentary behavior and adiposity-associated inflammation: the Multi-Ethnic Study of Atherosclerosis. Am J Prev Med. 2012 Jan;42(1):8-13.	Age group
Santos DA, Silva AM, Baptista F, Santos R, Vale S, Mota J, Sardinha LB. Sedentary behavior and physical activity are independently related to functional fitness in older adults. Exp Gerontol. 2012;47(12):908-12.	Other health outcome
Zhang M, Xie X, Lee AH, Binns CW. Sedentary behaviours and epithelial ovarian cancer risk. Cancer Causes Control. 2004 Feb;15(1):83-9.	Age group
Blair SN, Wei M. Sedentary habits, health, and function in older women and men. Am J Health Promot. 2000 Sep-Oct;15(1):1-8.	Review article
Helmink JH, Kremers SP, van Brussel-Visser FN, de Vries NK. Sitting time and Body Mass Index in diabetics and pre-diabetics willing to participate in a lifestyle intervention. Int J Environ Res Public Health. 2011;8(9):3747-58.	Age group

Wang S, Lin S, Zhou Y, Wang Z. Social and behavior factors related to aged Chinese women with osteoporosis. Gynecol Endocrinol. 2008;24(10):538-45.	Did not include sedentary behavior
Johnson KM, Nelson KM, Bradley KA. Television viewing practices and obesity among women veterans. J Gen Intern Med. 2006;21 Suppl 3:S76-81.	Age group
Vance DE, Wadley VG, Ball KK, Roenker DL, Rizzo M. The effects of physical activity and sedentary behavior on cognitive health in older adults. J Aging Phys Act. 2005;13(3):294-313.	Did not include physical activity as a covariate
Jenkins KR, Fultz NH. The relationship of older adults' activities and body mass index. J Aging Health. 2008;20(2):217-34.	Age group
Kesse-Guyot E, Charreire H, Andreeva VA, Touvier M, Hercberg S, Galan P, Oppert JM. Cross-sectional and longitudinal associations of different sedentary behaviors with cognitive performance in older adults. PLoS One. 2012;7(10):e47831	Age group
Koster A, Caserotti P, Patel KV, Matthews CE, Berrigan D, Van Domelen DR, Brychta RJ, Chen KY, Harris TB. Association of sedentary time with mortality independent of moderate to vigorous physical activity. PLoS One. 2012;7(6):e37696.	Age group
Arnardottir NY, Koster A, Van Domelen DR, Brychta RJ, Caserotti P, Eiriksdottir G, Sverrisdottir JE, Launer LJ, Gudnason V, Johannsson E, Harris TB, Chen KY, Sveinsson T. Objective measurements of daily physical activity patterns and sedentary behaviour in older adults: Age, Gene/Environment Susceptibility-Reykjavik Study. Age Ageing. 2013 Mar;42(2):222-9	Age group
Hamer M, Poole L, Messerli-Bürgy N. Television viewing, C-reactive protein, and depressive symptoms in older adults. Brain Behav Immun. 2013;1591(13)00181-5.	Age group
Demakakos P, Hamer M, Stamatakis E, Steptoe A. Low-intensity physical activity is associated with reduced risk of incident type 2 diabetes in older adults: evidence from the English Longitudinal Study of Ageing. Diabetologia. 2010 Sep;53(9):1877-85.	Age group
Hamer M, Stamatakis E. Screen-based sedentary behavior, physical activity, and muscle strength in the English longitudinal study of ageing. PLoS One. 2013 Jun 3;8(6):e66222	Age group
Gomez-Cabello A, Pedrero-Chamizo R, Olivares PR, Luzardo L, Juez-Bengoechea A, Mata E, Albers U, Aznar S, Villa G, Espino L, Gusi N, Gonzalez-Gross M, Casajus JA, Ara I; EXERNET Study Group. Prevalence of overweight and obesity in non-institutionalized people aged 65 or over from Spain: the elderly EXERNET multi-centre study. Obes Rev. 2011 Aug;12(8):583-92.	Descriptive analysis
Gautam R, Saito T, Kai I. Leisure and religious activity participation and mental health: gender analysis of older adults in Nepal. BMC Public Health. 2007;22(7):299.	Did not include physical activity as a covariate

SUPPLEMENTARY FILE 3

Gardiner PA, Healy GN, Eakin EG, Clark BK, Dunstan DW, Shaw JE, Zimmet PZ, and Owen N. Associations between television viewing time and overall sitting time with the metabolic syndrome in older men and women: the Australian Diabetes, Obesity and Lifestyle study. JAGS. 2011;59(5):788-796

Design: 2. Cross-sectional
Risk of Bias: -1. **Selection Bias**: Although the selected sample was not representative of the general population (more educated than non-participants) the association between the exposure and disease should not change in non-participants. **Information bias**: Television viewing time and overall sitting time questionnaires are reliable for use at the population level.
Imprecision: -1. In women TV associated with metabolic syndrome (Q1 VS Q4 OR 1.42 (1.01–2.01), lower HDL (Q1 VS Q4 1.64 (1.06–2.54) and glucose intolerance (Q1 VS Q4 1.45 1.01–2.09). Sitting time associated with metabolic syndrome (Q1 VS Q4 - MEN - 1.56 1.09–2.24; WOMEN 1.57 1.02–2.41), high TG (1.61 (Q1 VS Q4 - MEN - 1.01–2.58; WOMEN 1.66 (1.14–2.41), abdominal obesity (Q1 VS Q4 - WOMEN 1.81 (1.21–2.70) and low HDL (Q1 VS Q4 - MEN 1.78; 1.05–3.02)
Indirectness: -1. "Metabolic syndrome is a clustering of cardiovascular disease risk factors, and its presence is predictive of type 2 diabetes mellitus and all-cause mortality."
Inconsistency: -1. Some of the metabolic biomarkers showed a statistically significance only for one of the sex.
Magnitude of effect: 0. In women TV associated with metabolic syndrome (Q1 VS Q4 OR 1.42 (1.01–2.01), lower HDL (Q1 VS Q4 1.64 (1.06–2.54) and glucose intolerance (Q1 VS Q4 1.45 1.01–2.09). Sitting time associated with metabolic syndrome (Q1 VS Q4 - MEN - 1.56 1.09–2.24; WOMEN 1.57 1.02–2.41), high TG (1.61 (Q1 VS Q4 - MEN - 1.01–2.58; WOMEN 1.66 (1.14–2.41), abdominal obesity (Q1 VS Q4 - WOMEN 1.81 (1.21–2.70) and low HDL (Q1 VS Q4 - MEN 1.78; 1.05–3.02)
Confounding adjustment: +1. age, education, physical activity, self-rated health, employment, diet, smoking, and alcohol intake and for hormone replacement therapy and strogen use in women.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Lynch BM, Dunstan DW, Winkler E, Healy GN, Eakin E, and Owen N. Objectively assessed physical activity, sedentary time and waist circumference among prostate cancer survivors: findings from the National Health and Nutrition Examination Survey (2003-2006). Eur J Cancer Care. 2011;20:514-519.

Design: 2. Cross-Sectional
Risk of Bias: -1. **Selection Bias**: No presence. **Information bias**: - **1** Prostate cancer status was self-reported.
Imprecision: -1. Sedentary time was not associated with waist circumference (0.678; CI 95% -1.389-2.745; p=0.498). However, with comparatively wide confidence intervals that encompassed some clinically meaningful effect sizes, it is possible that larger studies with more precision could have different findings.
Indirectness: -1. "Cancer survivors have an increased risk of morbidity and premature mortality related to other chronic diseases, particularly cardiovascular disease."
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: 0. Sedentary time was not associated with waist circumference (β 0.678; CI 95% -1.389-2.745; p=0.498)
Confounding adjustment: +1. Age, educational attainment and total energy intake. Model 3: age, educational attainment, total energy intake, and moderate-to-vigorous intensity activity.
Dose-response: 0. Dose-response relationship could not be detected in this article.

George SM, Moore SC, Chow WH, Schatzkin A, Hollenbeck AR, and Matthews CE. A Prospective Analysis of Prolonged Sitting Time and Risk of Renal Cell Carcinoma Among 300,000 Older Adults. Ann Epidemiol 2011;21:787–790.

Design: 2. Prospective Cohort
Risk of Bias: -1. **Selection Bias**: No presence. **Information bias**: Health related behaviours, BMI and dietary intake by self-reported questionnaires.
Imprecision: -1. Watching television or videos for 7 or more hours versus less than 1 hour per day was 0.96 (95%CI: 0.66, 1.38; p trend = 0.707) (Table 1). The HR for those whose total sitting time was 9 or more hours versus less than 3 hours per day was 1.11 (95% CI: 0.87, 1.41; p trend = 0.765)
Indirectness: 0. "Renal Cancer Cell"
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: 0. Watching television or videos for 7 or more hours versus less than 1 hour per day was 0.96 (95%CI: 0.66, 1.38; p trend = 0.707) (Table 1). The HR for those whose total sitting time was 9 or more hours versus less than 3 hours per day was 1.11 (95% CI: 0.87, 1.41; p trend = 0.765)
Confounding adjustment: +1. age, sex, race, history of diabetes, smoking, alcohol intake, diet quality, energy intake, and recreational moderate-vigorous physical activity.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Stamatakis E, Davis M, Stathi A, and Hamer M. Associations between multiple indicators of objectively-measured and self-reported sedentary behaviour and cardiometabolic risk in older adults. Prev Med 2012;54:82-87.

Design: 2. Cross-Sectional
Risk of Bias: -1. **Selection Bias**: Had a response rate of 64%. Compared to those excluded, those included in analysis 1 were younger and more likely to have finished education after the age of 18, drink above the recommended limit, eat more fruit/vegetable, report less SB and more MVPA, and have lower GHQ scores. Compared to those excluded from analysis 2, those included were younger and more likely to be on CVD medication, have lower GHQ scores, and report less SB and more MVPA. Although the sample used in the self-reported analyses is roughly representative of the target population which adds to the ecological validity of the corresponding results, the sample size decreased in model 1 and model2 **Information bias**: no presence.
Imprecision: 0. Total self-reported leisure-time SB showed multivariable-adjusted (including for moderate-to-vigorous physical activity) associations with BMI (beta for mean difference in BMI per 30 min/day extra SB: 0.088 kg/m2 , 95% CI 0.047 to 0.130); waist circumference (0.234, 0.129 to 0.339 cm); cholesterol ratio (0.018, 0.005 to 0.032) and diabetes (odds ratio per 30 min/day extra SB: 1.059, 1.030 to 1.089). Similar associations were observed for TV time while non-TV self-reported SB showed associations only with diabetes (1.057, 1.017 to 1.099). Accelerometry SB was associated with waist circumference only (0.633, 0.173 to 1.093.
Indirectness: -1. "Many of the chronic conditions which older adults suffer including cardiovascular disease, high blood pressure, and type 2 diabetes could be reduced through modification of health behaviours."
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: 0. Total self-reported leisure-time SB showed multivariable-adjusted (including for moderate-to-vigorous physical activity) associations with BMI (beta for mean difference in BMI per 30 min/day extra SB: 0.088 kg/m2 , 95% CI 0.047 to 0.130); waist circumference (0.234, 0.129 to 0.339 cm); cholesterol ratio (0.018, 0.005 to 0.032) and diabetes (odds ratio per 30 min/day extra SB: 1.059, 1.030 to 1.089). Similar associations were observed for TV time while non-TV self-reported SB showed associations only with diabetes (1.057, 1.017 to 1.099). Accelerometry SB was associated with waist circumference only (0.633, 0.173 to 1.093.
Confounding adjustment: +1. Age, sex, employment status, smoking, education, depression (GHQ score) alcohol consumption, fruit and vegetable consumption, cardiovascular medication (diabetes medication for Hb1Ac), frequency of unhealthy foods consumption, and self-reported MVPA
Dose-response: 0. Dose-response relationship could not be detected in this article.

Campbell PT, Patel AV, Newton CC, Jacobs EJ, and Gapstur SM. Associations of recreational physical activity and leisure time spent sitting with colorectal cancer survival. J Clin Oncol 2013;31(7):876-885

Design: 2. Prospective Cohort
Risk of Bias: -1. **Selection Bias**: No presence **Information bias**: Although leisure time spent sitting should be reliable and valid (there is no citation of this), self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: 0. Spending 6 or more hours per day of leisure time sitting compared with fewer than 3 hours per day was associated with higher all-cause mortality (prediagnosis sitting time: RR, 1.36; 95% CI, 1.10 to 1.68; postdiagnosis sitting time: RR, 1.27; 95% CI, 0.99 to 1.64).
Indirectness: 0. "Colorectal cancer diagnoses were verified through medical records or linkage with state cancer registries when medical records could not be obtained.
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: 0. Spending 6 or more hours per day of leisure time sitting compared with fewer than 3 hours per day was associated with higher all-cause mortality (prediagnosis sitting time: RR, 1.36; 95% CI, 1.10 to 1.68; postdiagnosis sitting time: RR, 1.27; 95% CI, 0.99 to 1.64).
Confounding adjustment: +1. age at diagnosis; sex; smoking status; body mass index; red meat intake; Surveillance, Epidemiology, and End Results (SEER) summary stage at diagnosis; recreational physical activity; and education.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Martinez-Gomez D, Guallar-Castillón P, León-Munoz LM, López-Garcia E, and Rodríguez-Artalejo F. Combined impact of traditional and non-traditional health behaviors on mortality: A national prospective cohort study in Spanish older adults. BMC Med 2013;22(11):47

Design: 2. Prospective Cohort
Risk of Bias: -1. **Selection Bias**: No presence **Information bias**: lifestyle was self-reported, which may have led to recall bias, particularly for assessing physical activity and non-traditional health behaviors).
Imprecision: 0. Avoiding excessive sitting had the strongest inverse association (HR = 0.70, 95% CI: 0.60 to 0.82) with mortality. In addition, individuals who were less active/inactive and spent ≥8 h/d seated, those who were very/moderately physically active and spent <8 h/d seated showed a fully-adjusted mortality HR = 0.44 (95% CI: 0.36 to 0.52).
Indirectness: 0. Mortality was the main objective.
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: +1. Avoiding excessive sitting had the strongest inverse association (HR = 0.70, 95% CI: 0.60 to 0.82) with mortality. In addition, individuals who were less active/inactive and spent ≥8 h/d seated, those who were very/moderately physically active and spent <8 h/d seated showed a fully-adjusted mortality HR = 0.44 (95% CI: 0.36 to 0.52).
Confounding adjustment: +1. age, sex, and educational attainment, occupational status, alcohol intake, former drinking, extreme sleep durations, BMI, waist circumference, systolic blood pressure, hypercholesterolemia status, coronary heart disease, stroke, diabetes mellitus, hip fracture, cancer, never smoking or quitting tobacco >15 years very/moderately physically active, healthy diet score > median in the cohort, sleeping 7 to 8h/d, interaction with friends daily.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Geda F, Silber TC, Roberts RO, Knopman DS, Christianson TJ, Pankratz VS, Boeve BF, Tangalos EG, and Petersen RC. Computer activities, physical exercise, aging, and mild cognitive impairment: a population-based study. Mayo Clin Proc. 2012;87(5):437-442

Design: 2. Case-Control
Risk of Bias: -1. **Selection Bias**: No information of non-participants. **Information bias**: Another limitation of our study is recall bias, which is an unavoidable drawback of any survey –based study. However, the data on cognitive activities were collected before determination of whether a person had MCI
Imprecision: -1. Compared with the reference group (ie, no moderate physical exercise and no computer use), computer use but no exercise showed a protective factor (OR [95% CI], 0.53 [0.27-1.02]; P .058) to mild impairment.
Indirectness: -1. Mild cognitive impairment (MCI) is an intermediate stage between the cognitive changes of normal aging and dementia
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: +1. Compared with the reference group (ie, no moderate physical exercise and no computer use), computer use but no exercise showed a protective factor (OR [95% CI], 0.53 [0.27-1.02]; P .058) to mild impairment.
Confounding adjustment: 0. age, sex, education, depression, medical comorbidity, and caloric intake.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Frank L, Keer J, Rosenberg D, and King A. Healthy Aging and Where You Live: Community Design Relationships With Physical Activity and Body Weight in Older Americans. J Phys Act Health. 2010;7(Suppl 1):S82-S90

Design: 2. Cross-Sectional
Risk of Bias: -2. **Selection Bias**: it was conducted in a region with limited variability in urban form **Information bias**: Although "traveled in a car at least 1 hour a day" vs. "did not travel in a car for more than 1 hour a day" were derived from the travel survey data measurement should be reliable and valid, self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: -1. 1 hour or more spent sitting in car was not associated with overweight (0.86 OR. 95% CI 0.51-1.22) and obesity (0.67 OR; 95 CI% 0.41-1.06) when compared with <1 hour in car.
Indirectness: -1. "Large numbers of older adults are afflicted by chronic disease related to obesity, including heart disease, hypertension, cancer, diabetes, COPD, and arthritis."
Inconsistency: 0. Heterogeneity not could be detected in this article.
Magnitude of effect: 0. 1 hour or more spent sitting in car was not associated with overweight (0.86 OR. 95% CI 0.51-1.22) and obesity (0.67 OR; 95 CI% 0.41-1.06) when compared with <1 hour in car.
Confounding adjustment: +1. age, living alone, household income, car, ethnicity, education, gender, walkability, walking trip, and moderate-vigorous physical activity.
Dose-response: 0. Dose-response relationship could not be detected in this article

Gomez-Cabello A, Vicente-Rodriguez G, Pindado M, Vila S, Casajús JA, Pradas de la Fuente F, and Ara I. Increased risk of Obesity and central Obesity in sedentary postmenopausal Women. Nutr Hosp. 2012;27(3):865-870.

Design: 2. Cross-Sectional
Risk of Bias: -1. **Selection Bias**: Although the participation rate of the study was 87.1%, the sample included non-institutionalized seniors, from urban cities (6 regions).
Information bias: Although non-physical hobby activities were derived from the travel survey data measurement should be reliable and valid, self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: -1. Sitting increased the risk of overweight (OR 1.7; 95% CI 1.06-2.82), obesity (OR 2.7; 95% CI 1.62-4.66) and abdominal obesity (OR 1.8; 95% CI 1.20-2.64).
Indirectness: -1. "Teniendo en cuenta que estos cambios en la composición corporal están relacionados con un aumento de problemas de salud, como hipertensión, problemas cardiovasculares, diabetes, artritis, algunos tipos de cáncer y mortalidad prematura"
Inconsistency: 0. Heterogeneity not could be detected in this article.
Magnitude of effect: +1. Sitting increased the risk of overweight (OR 1.7; 95% CI 1.06-2.82), obesity (OR 2.7; 95% CI 1.62-4.66) and abdominal obesity (OR 1.8; 95% CI 1.20-2.64).
Confounding adjustment: 0. Walking hours
Dose-response: 0. Dose-response relationship could not be detected in this article.

Balboa-Castillo T, León-Munoz LM, Graciani A, Rodríguez-Artalejo F, Guallar-Castillón P. Longitudinal association of physical activity and sedentary behavior during leisure time with health-related quality of life in community-dwelling older adults. Health and Qual Life Outcomes 2011;27;9:47

Design: 2. Prospective Cohort
Risk of Bias: -2. **Selection Bias**: Losses to follow-up could affect the representativeness of our cohort. **Information bias**: Although sitting measurement should be reliable and valid, self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: -1. Lower quartile of sitting time, those in the upper quartile had worse scores on the scales of physical functioning (β -9.21; 95% CI -13.36 to -5.04), physical role (β -11.96; 95% CI -19.33 to -4.59), bodily pain (β -6.58; 95% CI -11.51 to -1.64), vitality (β 5.04; 95% CI -9.21 to -0.88) and social functioning (β 6.36 95% CI -11.17 to -1.56).
Indirectness: 0. Physical activity reduces the risk of numerous diseases, like ischemic heart disease,[1] stroke,[2] diabetes mellitus[3], and cognitive disorders,[4] as well as total mortality.
Inconsistency: 0. Heterogeneity was not mesured found.
Magnitude of effect: +1 Lower quartile of sitting time, those in the upper quartile had worse scores on the scales of physical functioning (β -9.21; 95% CI -13.36 to -5.04), physical role (β -11.96; 95% CI -19.33 to -4.59), bodily pain (β -6.58; 95% CI -11.51 to -1.64), vitality (β 5.04; 95% CI -9.21 to -0.88) and social functioning (β 6.36 95% CI -11.17 to -1.56).
Confounding adjustment: +1. Age, sex, education, size of municipality of residence, smoking, alcohol consumption, coronary disease, stroke, cancer, chronic obstructive pulmonary disease, diabetes mellitus, arterial hypertension, physical activity, score in SF-36 in the previous measurement.
Dose-response: +1. Lower quartile of sitting time, those in the upper quartile had worse scores on the scales of physical functioning (β -9.21; 95% CI -13.36 to -5.04; p trend<0.0001), physical role (β -11.96; 95% CI -19.33 to -4.59; p trend =0.005), bodily pain (β -6.58; 95% CI -11.51 to -1.64; p trend 0.03), vitality (β 5.04; 95% CI -9.21 to -0.88; p trend = 0.01), social functioning (β 6.36 95% CI -11.17 to -1.56; p trend 0.008) and mental health (β-5.04; 95% CI -8.87- -1.21; p trend 0.009)

Buman MP, Hekler EB, Haskell WL, Pruitt L, Conway TL, Cain KL, Sallis JF, Saelens BE, Frank LD, King AC. Objective Light-Intensity Physical Activity Associations With Rated Health in Older Adults. Am J Epidemiol 2010;172:1155–1165

Design: 2. Cross-Sectional
Risk of Bias: -2. **Selection Bias**: Although our physical activity estimates seem in line with those from a nationally representative sample, racial minorities and less educated individuals may have been underrepresented, and these groups are likely to report their health more poorly. **Information bias**: study relied on rated health parameters and did not assess objective health indicators
Imprecision: 0. Sedentary time was positively related to physical health (β -0.02; 95% CI -0.00 - -0.03; p< 0.0001) and psychological well-being (β -0.03; 95% CI -0.05 - -0.01; p< 0.001).
Indirectness: -1. "Objective measures of light physical activity are therefore needed to examine the impact of such activities on health and well-being
Inconsistency: 0. Heterogeneity not could be detected in this article.
Magnitude of effect: 0. Sedentary time was positively related to physical health (β -0.02; 95% CI -0.00 - -0.03; p< 0.0001) and psychological well-being (β -0.03; 95% CI -0.05 - -0.01; p< 0.001).
Confounding adjustment: +1. age, gender, race, education, senior housing resident status, current smoking status, site, marital status, neighborhood-level walkability, neighborhood-level income, and accelerometer wear time, and other activity threshold.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Hamer M, Venuraju SM, Lahiri A, Rossi A, and Steptoe A. Objectively assessed physical activity, sedentary time, and coronary artery calcification in healthy older adults. Artriolscler Thromb Vasc Biol 2012;32:500-505

Design: 2. Cross-Sectional
Risk of Bias: -2. **Selection Bias**: The participants included in the present analysis were generally healthier than the overall Whitehall II sample and demonstrated higher activity levels compared with similar aged British cohort. **Information bias**: The accelerometry device used in the present study could not distinguish between sitting and standing.

Imprecision: -1. There was no association between sedentary time and presence of detectable CAC (OR 0.93; 95% CI 0.54–1.59)
Indirectness: -1. CAC measures cannot reliably identify more vulnerable lesions.

Inconsistency: 0. Heterogeneity not could be detected in this article.
Magnitude of effect: 0. There was no association between sedentary time and presence of detectable CAC (OR 0.93; 95% CI 0.54–1.59)
Confounding adjustment: +1. Age, sex, physical activity registered time, employment, statins use, systolic blood pressure, HDL, TG, BMI, Hb A1c.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Hamer M, Venuraju SM, Urbanova L, Lahiri A, and Steptoe A. Physical activity, sedentary time, and pericardial fat in healthy older adults. Obesity. 2012;20:2113–2117.

Design: 2. Cross-Sectional
Risk of Bias: -2. **Selection Bias**: The participants included in the present analysis were generally healthier than the overall Whitehall II sample and demonstrated higher activity levels compared with similar aged British cohort. **Information bias**: The accelerometry device used in the present study could not distinguish between sitting and standing.

Imprecision: 0. Sedentary time was also associated with pericardial fat (β= 0.081, 95% CI, 0.022, 0.14), although associations for sedentary time did not remain significant, after adjustment for MVPA (β = 0.033, 95% CI, –0.031, 0.096).
Indirectness: -1. "Pericardial fat surrounds the coronary arteries and has been associated with cardiovascular risk factors and markers of subclinical atherosclerosis, independently of overall adiposity"
Inconsistency: 0. Heterogeneity not could be detected in this article.
Magnitude of effect: 0. Sedentary time was also associated with pericardial fat (β= 0.081, 95% CI, 0.022, 0.14), although associations for sedentary time did not remain significant, after adjustment for MVPA (β = 0.033, 95% CI, –0.031, 0.096).
Confounding adjustment: +1. Age, sex, registered time, BMI, HDL, LDL, blood pressure, glycated hemoglobin, smoking, statins, and MVPA.
Dose-response: 0. Dose-response relationship could not be detected in this article.

Bankoski A, Harris TB, McClain JJ, Brychta RJ, Caserotti P, Chen KY, Berrigan D, Troiano RP, and Koster A. Sedentary Activity Associated With Metabolic Syndrome Independent of Physical Activity. Diabetes Care. 2011;34:497–503.

Design: 2. Cross-Sectional
Risk of Bias: 0. **Selection Bias**: no presence. **Misclassification bias**: no presence
Imprecision: -1. A higher percentage of time sedentary (Q1 vs Q2 - OR 1.58; 95% IC 1.03 - 2.24) and fewer sedentary breaks (OR 1.53; 95% CI 1.05 - 2.23) were associated with a significantly greater likelihood of metabolic syndrome
Indirectness: -1. "People with metabolic syndrome have an increased risk to develop health problems such as heart disease, diabetes, and stroke"
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: 0. A higher percentage of time sedentary (Q1 vs Q2 - OR 1.58; 95% IC 1.03 - 2.24) and fewer sedentary breaks (OR 1.53; 95% CI 1.05 - 2.23) were associated with a significantly greater likelihood of metabolic syndrome
Confounding adjustment: +1. Age, sex, ethnicity, education, alcohol intake, smoking, BMI, diabetes, heart disease and physical activity
Dose-response: 0. Dose-response relationship could not be detected in this article.

Gomez-Cabello A, Pedreto-Chamizo R, Olivares PR, Hernández_Perera R, Rodríguez-Marroyo JA, Mata E, Aznar S, Villa JG, Espino-Torón L, Gusi N, González-Gross, Casajús JA, Ara I, and Vicente-Rodríguez G. Sitting time increases the overweight and obesity risk independently of walking time in elderly people from Spain. Maturitas. 2012;73(4):337–343.

Design: 2. Cross-Sectional
Risk of Bias: -1. **Selection Bias**: Only independent no institutionalized elderly were included in the present study. **Information bias**: BMI is not a the best marker of body composition to determine metabolic risk.
Imprecision: -1. Sitting time increases the risk of overweight-obesity (1.42 OR; 95% CI 1.06 - 1.89) and overfat (1.4 OR; 95% CI 1.14 - 1.74) in women and the risk of central obesity (1.74 OR; 95% CI 1.212 – 2.488) in men, independetly of walking time..
Indirectness: -1. "Taking into account that overweight, obesity and central obesity are associated with an increased risk of certain pathologies among older adults, including hypertension, cardiovascular disease, diabetes, dyslipidemia, arthritis, some cancers [4] and also with an earlier morbidity and functional limitation"
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: 0. Sitting time increases the risk of overweight-obesity (1.42 OR; 95% CI 1.06 - 1.89) and overfat (1.4 OR; 95% CI 1.14 - 1.74) in women and the risk of central obesity (1.74 OR; 95% CI 1.212 - 2488) in men, independetly of walking time..
Confounding adjustment: 0. age and walking time
Dose-response: 0. Dose-response relationship could not be detected in this article..

Gao X, Nelson ME, Tucker KL. Television viewing is associated with prevalence of metabolic syndrome in hispanic elders. Diabetes Care. 2007;30:694–700.

Design: 2. Cross-Sectional
Risk of Bias: 0. No presence. **Information bias**: No presence

Imprecision: -1. Each additional hour of television viewing was associated with a 19% greater likelihood of having the metabolic syndrome (odds ratio [OR] 1.19, 95% CI 1.1–1.3, P for trend 0.002). Subjects in the highest quartile of television watching had a risk for the metabolic syndrome 2.2 times (OR 2.2, 95% CI 1.1– 4.2) that for those in the lowest quartile
Indirectness: -1. "This syndrome is associated with diabetes, cardiovascular disease, and mortality."
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: +1. Each additional hour of television viewing was associated with a 19% greater likelihood of having the metabolic syndrome (odds ratio [OR] 1.19, 95% CI 1.1–1.3, P for trend 0.002). Subjects in the highest quartile of television watching had a risk for the metabolic syndrome 2.2 times (OR 2.2, 95% CI 1.1– 4.2) that for those in the lowest quartile
Confounding adjustment: +1. age (years), sex, ethnicity, BMI (except for abdominal obesity, high waist-to-hip ratio, and high BMI), education (years), household arrangement (married/lives with spouse, unmarried/lives with others, and unmarried/lives alone), smoking (current, former, and never), and current alcohol use (heavy drinker: more than one drink/day for women or two drinks/day for men, moderate drinker: less than these, and nondrinker, based on 13.2 g alcohol/drink), total energy intake (MJ/day), saturated fat intake (% total energy), polyunsaturated fat intake (% total energy), trans fat intake (% total energy), fruit and vegetable intake (servings/day), and physical activity score (in quartiles), and daily living score
Dose-response: +1. P for trend _0.002.

Inoue S, Sugiyama T, Takamiya T, Oka K, Owen N, and Shimomitsu T. Television Viewing Time is Associated with Overweight/Obesity Among Older Adults, Independent of Meeting Physical Activity and Health Guidelines. J Epidemiol 2012;22(1):50-56

Design: 2. Cross-Sectional
Risk of Bias: -2.**Selection Bias**: response rate: 66.9% **Information bias**: both the dependent and independent variables were measured by self-report
Imprecision: -1. As compared with the reference category (high TV/insufficient MVPA), the adjusted ORs (95% CI) of overweight/obesity were 0.93 (0.65, 1.34) for high TV/sufficient MVPA, 0.58 (0.37, 0.90) for low TV/insufficient MVPA, and 0.67 (0.47, 0.97) for low TV/sufficient MVPA.
Indirectness: -1. "might influence their cardiovascular health."
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: 0. As compared with the reference category (high TV/insufficient MVPA), the adjusted ORs (95% CI) of overweight/obesity were 0.93 (0.65, 1.34) for high TV/sufficient MVPA, 0.58 (0.37, 0.90) for low TV/insufficient MVPA, and 0.67 (0.47, 0.97) for low TV/sufficient MVPA.
Confounding adjustment: +1. sex, age, education, employment status, city of residence, smoking, drinking, and physical functioning
Dose-response: 0. Dose-response relationship could not be detected in this article.

Dogra S, Stathokostas L. Sedentary Behavior and Physical Activity Are Independent Predictors of Successful Aging in Middle-Aged and Older Adults. J Aging Res. 2012(2012);190654

Design: 2. Cross-Sectional
Risk of Bias: -1.**Selection Bias**: No presence **Information bias**: both the dependent and independent variables were measured by self-report
Imprecision: -1. Least sedentary older (< 2 hours) were more likely to have overall successful aging (OR 1.43; 95% 1.23-1.67), physical successful aging (OR 2.44; 95% CI 1.64-3.65) and Sociological successful aging (OR 1.25; 95% CI 1.00-1.55)
Indirectness: 0. "Successful aging (SA); a term used to represent the physical, psychological, and social success with which adults age."
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: +1. Least sedentary older (< 2 hours) were more likely to have overall successful aging (OR 1.43; 95% 1.23-1.67), physical successful aging (OR 2.44; 95% CI 1.64-3.65) and Sociological successful aging (OR 1.25; 95% CI 1.00-1.55).
Confounding adjustment: +1. age, marital status, income and physical activity
Dose-response: 0. A dose-response relationship was not tested. However, similarly, compared to sedentary older adults, moderately sedentary and least sedentary older adults were 38% (OR: 1.38; CI: 1.12–1.69) and 43% (OR: 1.43; CI: 1.23–1.67) more likely to be aging successfully overall.

Pavey TG, Peeters GG, and Brown WJ. Sitting-time and 9-year all-cause mortality in older women. Br J Sports Med. 2012;0:1–5

Desing: 2. Prospective Cohort
Risk of Bias: -1. **Selection Bias**: No presence **Information bias**: Although sitting measurement should be reliable and valid, self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: 0. Sitting time 4 to <8 hours (HR 0.90; 95% CI 0.79-1.03), 8 to <11 (HR 1.21; 95% CI 1.01 – 1.44), >11 (HR 1.24; 95% CI 0.98 – 1.56). Trend HR 1.03 (1.01 – 1.05).
Indirectness: 0. Mortality.
Inconsistency: 0. Heterogeneity was not measured found.
Magnitude of effect: +1 Sitting time 4 to <8 hours (HR 0.90; 95% CI 0.79-1.03), 8 to <11 (HR 1.21; 95% CI 1.01 – 1.44), >11 (HR 1.24; 95% CI 0.98 – 1.56). Trend HR 1.03 (1.01 – 1.05). A significant interaction (p=0.02) was found between sitting-time and physical activity (PA), with increased mortality risk for prolonged sitting only among participants not meeting PA guidelines (HR for sitting =8 h/day: 1.31, 95% CI 1.07 to 1.61); HR for sitting =11 h/day: 1.47, CI 1.15 to 1.93).
Confounding adjustment: +1. age, education, marital status, area, smoking, alcohol consumption, BMI, physical activity, number of chronic conditions, self-reported health and assistance with daily tasks.
Dose-response: +1. Trend HR 1.03 (1.01 – 1.05)

Gennuso KP, Gangnon RE, Matthews CE, Thraen-Borowski KM, and Colbert LH. Sedentary Behavior, Physical Activity, and Markers of Health in Older Adults. Med. Sci. Sports Exerc. 2013;45(8):1493.

Desing: 2. Cross-Sectional
Risk of Bias: 0.**Selection Bias**: No presence **Misclassification bias**: No presence
Imprecision: -1. Compared with sedentary, mortality HR were 0.91 (95% CI 0.76-1.10) in those who were newly sedentary, 0.86 (0.70-1.05) in formerly sedentary individuals, and 0.75 (0.62-0.90) in those who remained consistently non-sedentary. Less sedentary hour (first quartile) was protective for greater number of limitations in insufficient MVPA (0.48; 95% CI 0.29 – 0.79; P trend <001) and sufficient MVPA (0.83; 95% CI 0.43 – 1.62) when compared with higher quartile of sedentary hours.
indirectness: -1. "Cardiovascular disease, type 2 diabetes, cancer, mortality."
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: +1. Compared with sedentary, mortality HR were 0.91 (95% CI 0.76-1.10) in those who were newly sedentary, 0.86 (0.70-1.05) in formerly sedentary individuals, and 0.75 (0.62-0.90) in those who remained consistently non-sedentary. Less sedentary hour (first quartile) was protective for greater number of limitations in insufficient MVPA (0.48; 95% CI 0.29 – 0.79; P trend <001) and sufficient MVPA (0.83; 95% CI 0.43 – 1.62) when compared with higher quartile of sedentary hours
Confounding adjustment: +1. sex, age, educational level, smoking, alcohol consumption, BMI, physical activity, chronic lung disease, ischemic heart disease, diabetes mellitus, osteomuscular disease, cancer, SF-36, limitations in mobility, and limitations in agility.
Dose-response: +1. Less sedentary hour (first quartile) was protective for greater number of limitations in insufficient MVPA (0.48; 95% CI 0.29 – 0.79; P trend <001). P trend <0.01 for weight, waist circumference and CRP.

León-Muñoz LM, Martínez-Gómez D, Balboa-Castillo T, López-García E, Guallar-Castillón P, Rodríguez-Artalejo F. Continued Sedentariness, Change in Sitting Time, and Mortality in Older Adults. Med Sci Sports Exerc. 2013;45(8):1501-1507.

Desing: 2. Prospective Cohort
Risk of Bias: -1. **Selection Bias**: No presence **Information bias**: Although sitting measurement should be reliable and valid, self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: 0. Compared with sedentary, mortality HR were 0.91 (95% CI 0.76-1.10) in those who were newly sedentary, 0.86 (0.70-1.05) in formerly sedentary individuals, and 0.75 (0.62-0.90) in those who remained consistently non-sedentary
Indirectness: 0. Mortality.
Inconsistency: 0. Heterogeneity was not measured found.
Magnitude of effect: +1 Compared with sedentary, mortality HR were 0.91 (95% CI 0.76-1.10) in those who were newly sedentary, 0.86 (0.70-1.05) in formerly sedentary individuals, and 0.75 (0.62-0.90) in those who remained consistently non-sedentary
Confounding adjustment: +1. sex, age, educational level, smoking, alcohol consumption, BMI, physical activity, chronic lung disease, ischemic heart disease, diabetes mellitus, osteomuscular disease, cancer, SF-36, limitations in mobility, and limitations in agility.
Dose-response: +1. The average ST between 2001 and 2003 showed an inverse dose–response relationship (P for trend G0.001) with all-cause mortality from 2003 through 2011

Verghese J, Lipton RB, Katz MJ, Hall CB, Derby CA, Kuslansky G, mabrose AF, Sliwinski M, and Buschke H. Leisure Activities and the Risk of Dementia in the Elderly. N Engl J Med. 2003;348(25):2508-2516.

Design: 2. Prospective Cohort
Risk of Bias: -2. **Selection Bias**: volunteers who resided in the community; whites and subjects older than 75 years of age were overrepresented, as compared with the general population of those over 65 years of age **Information bias**: Although leisure activities measurement should be reliable and valid, self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: 0. Individuals that frequent are engaged in playing board games (HR 0.26; 95% CI 0.17-0.57), reading (HR 0.65; 95% CI 0.43-0.97), and playing musical instrument (HR 0.31; 95% CI 0.11-0.90) was less likely to develop dementia when compared with rare group.
Indirectness: 0. Dementia.
Inconsistency: 0. Heterogeneity was not measured found.
Magnitude of effect: +1 Individuals that frequent are engaged in playing board games (HR 0.26; 95% CI 0.17-0.57), reading (HR 0.65; 95% CI 0.43-0.97), and playing musical instrument (HR 0.31; 95% CI 0.11-0.90) was less likely to develop dementia when compared with rare group.
Confounding adjustment: +1. age, sex, educational level, presence or absence of medical illnesses, score on the Blessed Information–Memory–Concentration test, and participation or nonparticipation in other leisure activities.
Dose-response: 0. A dose-response relationship was not tested

Geda YE, Topazian HM, Roberts LA, Roberts RO, Knopman DS, Pankratz VS, Christianson TJ, Boeve BF, Tangalos EG, Ivnik RJ, Petersen RC. Engaging in cognitive activities, aging, and mild cognitive impairment: a population based study. J Neuropsychiatry Clin Neurosci. 2011;23(2):149-154.

Desing: 2. Cross-Sectional
Risk of Bias: -1.**Selection Bias**: No presence **Information bias**: Although television time measurement should be reliable and valid, self-reported instruments tends to misclassificate the information (non-differentially in this case).
Imprecision: 0. Reading books (OR 0.67; 95% CI 0.49 –0.94), playing games (OR 0.65; 95% CI 0.47– 0.90), craft activities (OR 0.66; 95% CI 0.47– 0.93), computer activities (OR 0.50; 95% CI 0.36 –0.71), and watching television (OR 0.48; 95% CI 0.27– 0.86) were significantly associated with decreased odds of having MCI
Indirectness: -1. "Mild cognitive impairment (MCI) is the intermediate stage between the cognitive changes of nor- mal aging and those of dementia."
Inconsistency: 0. Heterogeneity could not be detected in this article.
Magnitude of effect: +1. Reading books (OR 0.67; 95% CI 0.49 –0.94), playing games (OR 0.65; 95% CI 0.47– 0.90), craft activities (OR 0.66; 95% CI 0.47– 0.93), computer activities (OR 0.50; 95% CI 0.36 –0.71), and watching television (OR 0.48; 95% CI 0.27– 0.86) were significantly associated with decreased odds of having MCI
Confounding adjustment: +1. age, sex, education, depression, medical comorbidity, and physical exercise
Dose-response: 0. A dose-response relationship was not tested

PRISMA 2009 Checklist

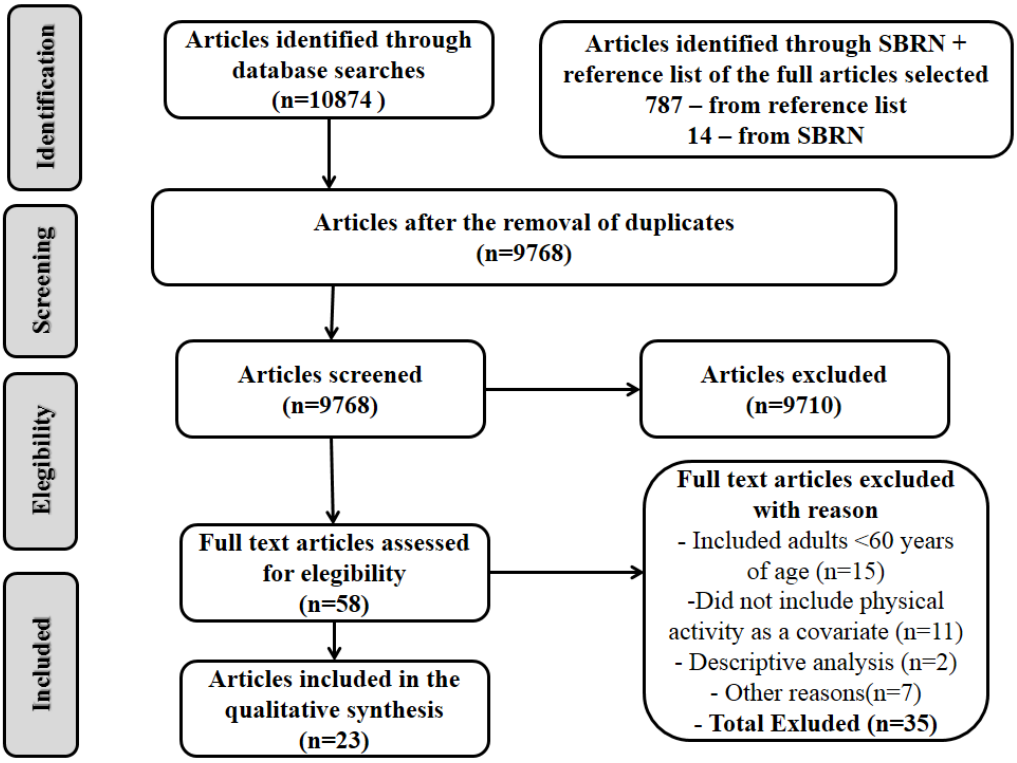
Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4-5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4-5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5 and Suppl Fil 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6 and Suppl Fil 2
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Suppl Fil 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Suppl Fil 3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Suppl Fil 3
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16-17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	18
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	20

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

Figure 1 - Flow diagram of the studies included in the systematic review.



*SBRN - Sedentary Behaviour Research Network

ANEXO B

ARTIGO 2

Sedentary behaviour and health outcomes: an overview of systematic reviews

Sedentary behavior and health outcomes: an overview of systematic reviews

Correspondence to Leandro Fornias Machado de Rezende, Rua Taipas 77, ap. 22, São Caetano do Sul, SP, Brazil, CEP 09560-200. Telephone number: + 55 11 3593-9793. Fax number: + 55 114427-8120. E-mail: lerezende@usp.br

Leandro Fornias Machado de Rezende, Department of Preventive Medicine, University of São Paulo School of Medicine, São Paulo, Brazil, and Centre of Studies and Laboratory of Physical Fitness from São Caetano do Sul, São Caetano do Sul, Brazil

Maurício Lopes, Department of Preventive Medicine, University of São Paulo School of Medicine, São Paulo, Brazil

Juan Pablo Rey-López, Department of Preventive Medicine, University of São Paulo School of Medicine, São Paulo, Brazil

Victor Keihan Rodrigues Matsudo, Centre of Studies and Laboratory of Physical Fitness from São Caetano do Sul, São Caetano do Sul, Brazil.

Olinda do Carmo Luiz, Department of Preventive Medicine, University of São Paulo School of Medicine, São Paulo, Brazil

Keywords: sedentary lifestyle; chronic disease; mortality; public health

Word count: 3,738

ABSTRACT

Objective

1) To synthesize the current observational evidence for the association between sedentary behavior and health outcomes using information from systematic reviews. 2) To assess the methodological quality of the systematic reviews found.

Methodology/Principal Findings

Medline; *Excerpta Medica* (Embase); PsycINFO; and Web of Science were searched for reviews published up to September 2013. Additional publications were provided by Sedentary Behaviour Research Network members. The methodological quality of the systematic reviews was evaluated using recommended standard criteria from AMSTAR. For each review, improper use of causal language in the description of their main results/conclusion was evaluated. Altogether, 1,044 review titles were identified, 144 were read in their entirety, and 27 were included. Based on the systematic reviews with the best methodological quality, we found in children and adolescents, strong evidence of a relationship between time spent in sedentary behavior and obesity. Moreover, moderate evidence was observed for blood pressure and total cholesterol, self-esteem, social behavior problems, physical fitness and academic achievement. In adults, we found strong evidence of a relationship between sedentary behavior and all-cause mortality, fatal and non-fatal cardiovascular disease, type 2 diabetes and metabolic syndrome. In addition, there is moderate evidence for incidence rates of ovarian, colon and endometrial cancers.

Conclusions

This overview based on the best available systematics reviews, shows that sedentary behavior may be an important determinant of health, independently of physical activity. However, the relationship is complex because it depends on the type of sedentary behavior and the age group studied. The relationship between sedentary behavior and many health outcomes remains uncertain; thus, further studies are warranted.

INTRODUCTION

Physical inactivity, or lack of moderate to vigorous physical activity,[1] is strongly related to the main non-communicable diseases such as coronary heart disease,[2] type 2 diabetes[3] and certain types of cancer.[4] In addition, many studies have demonstrated that physical inactivity is an important determinant of all-cause mortality.[5,6]

However, recently a new paradigm in the physical activity field has emerged.[7] Many epidemiological studies have consistently shown that spending excessive time engaged in sedentary behaviors may have a negative impact on several health outcomes, independently of moderate to vigorous physical activity.[8,9] Sedentary behavior is defined as time spent engaged in sitting or lying down activities that require an energy expenditure of 1.0 to 1.5 basal metabolic rates.[10] Sedentary activities are described in different domains, such as work, leisure/entertainment and commuting.[11-13] In addition, these activities have been categorized as nondiscretionary or discretionary. Behaviors such as sitting at work, school or while commuting via car or bus are nondiscretionary, whereas watching television, reading, using a computer, and playing video games are discretionary.[14]

During the last decade, a growing number of systematic reviews have been published.[15-41] However, most of them have focused on one particular sedentary behavior (i.e. television viewing), age group or health outcome and have drawn divergent conclusions. Therefore, an overview of systematic reviews is needed to cover all types of sedentary behavior, health outcomes and age groups, taking into account the methodological quality of the systematic reviews. This overview method has been used in medical and behavioral studies.[42,43].

Thus, the aim of this overview was to synthesize the current evidence of the relationship between sedentary behavior and health outcomes during the time periods reported in the systematic reviews. Moreover, for each systematic review a methodological quality assessment was performed.

METHODS

Criteria for considering reviews for inclusion

To be included in our overview, reviews had to describe the search methods used and the inclusion criteria of the original articles.

Article selection

A comprehensive search was performed up until September 2, 2013 using Medline; *Excerpta Medica* (Embase); PsycINFO; and Web of Science. Keywords related to exposure (sedentary behavior, sedentary lifestyles, sedentary time, sitting time, television viewing, driving, screen-based, video game, computer, and screen time) and method ("systematic review" and "meta-analysis") were included in the search. Detailed information on the combinations of search terms used in our search strategy is shown in Supplementary File 1. The systematic reviews retrieved were imported into the EndNote Web® reference management software (Thomson Reuters, Carlsbad, CA, USA). All eligible articles were evaluated by two independent reviewers, who examined all of the empirical evidence and discussed the discrepancies. Disagreements between the two reviewers were settled by a third reviewer. Reference lists in the selected systematic

reviews and approximately 400 individuals affiliated with the Sedentary Behaviour Research Network (professors, researchers, and students), were contacted in an attempt to identify more articles for inclusion in our overview.

Inclusion and exclusion criteria

To be included in the overview, articles had to be systematic reviews, with or without a meta-analysis that examined the relationship between sedentary behavior and health outcomes among observational studies. We excluded the following types of reviews: reviews in which sedentary behavior was inappropriately defined (as if it were synonymous with physical inactivity, i.e. failing to meet the minimum physical activity recommendations); and narrative reviews of the literature. Because of the large number of review articles initially selected, we excluded those examining other aspects of sedentary behavior i.e. interventions to reduce sedentary behavior; determinants/correlates of sedentary behavior; the tracking of sedentary behavior; and different methods for measuring sedentary behavior.

Data extraction

All eligible systematic reviews included were examined and extracted independently by two reviewers (LFMR and MRL). The data extracted included information on author(s), year, age group, type of sedentary behavior, outcome measure, whether a meta-analysis was conducted, and quality assessment of the original studies (Supplementary File 2),

eligibility criteria and evaluation of physical activity as a covariate (Supplementary File 3).

Quality Assessment of Systematic Reviews

All included reviews were evaluated by two independent reviewers (LFMR and JPRL) using the Assessing the Methodological Quality of Systematic Reviews (AMSTAR) tool (Supplementary File 4).[44,45] AMSTAR contains 11-items to appraise the methodological aspects of the systematic reviews. All 11-items were scored as "Yes", "No", "Can't Answer" or "Not Applicable". AMSTAR comprises the following items:

1. 'a priori' design provided;
2. duplicate study selection/data extraction;
3. comprehensive literature search;
4. status of publication as inclusion criteria (i.e., grey or unpublished literature);
5. list of studies included/excluded provided;
6. characteristics of included studies documented;
7. scientific quality assessed and documented;
8. appropriate formulation of conclusions (based on methodological rigor and scientific quality of the studies);
9. appropriate methods of combining studies (homogeneity test, effect model used and sensitivity analysis);
10. assessment of publication bias (graphic and/or statistical test); and
11. conflict of interest statement.

The quality of the systematic reviews were evaluated according to the scores obtained using AMSTAR. The score for each item was determined as: yes = 1 point and no/N/A = 0. Therefore, the total score could range from 0 to 11.

Level of Scientific Evidence

The level of evidence for each health outcome was classified as *strong, moderate, insufficient or no evidence* (Supplementary file 5). To determine the level of evidence for each health outcome, we considered the following steps:1) Selection of the best systematic reviews according to the AMSTAR score.

2) The conclusions reported for the best systematic review were maintained if these additional quality criteria were achieved:

a) conclusions based on longitudinal studies;

b) reviews that included conclusions based on studies with high methodological quality; and

c) reviews that took into account several covariates (especially physical activity).

If the best systematic reviews did not take into account any of these additional items, we decreased the level of the evidence reported to the next lower level. For example, if a review had a *strong level of evidence* and it did not include the above criteria, we then classified it as a *moderate level of evidence*.

Use of causative language

For each review, improper use of causal language in the description of their main results/conclusion was evaluated (Supplementary File 6). A review was rated as causal if causal language was used (i.e., "Low sedentary behavior is *protective* of obesity"). Reviews were rated as qualified causal if words such as "*may*" or "*suggest*" were included to describe their main results. Finally, reviews were considered acceptable if the inference was based on *associations* or *relationships*. This methodology has been used by Brown et al.[46]

Ethics

No ethical approval was required.

RESULTS

A total of 1044 potentially relevant articles were initially retrieved from the databases searched. Of those 1044 articles, 424 were retrieved from Medline, 248 from Embase, 333 from Web of Science, and 39 from PsycINFO. (Figure 1) Another 33 articles were included, that were selected from among the titles suggested by our Sedentary Behaviour Research Network contacts. After the exclusion of duplicate entries, 893 articles remained. After screening the titles and abstracts, we selected 114 articles to be read in their entirety. Of those, only 27 met the criteria for inclusion in our overview.

We found no review articles examining sedentary behavior in middle-aged adults or in the elderly (individuals over 65 years of age). As shown in Supplementary File 2, we included 13 reviews investigating sedentary behavior in children and adolescents (0–18

years of age).[15-27]. In addition, we included 8 articles investigating sedentary behavior in adults over 18 years of age,[21,28-34] and 8 articles investigating sedentary behavior in a variety of age groups.[35-41] One article addressed the topic in adults and in children.[21] Consequently, that study was included in both categories and was, therefore, counted twice. One review[47] about sedentary behavior and schizophrenia and bipolar disorder was identified in our search strategy, but it was excluded in our overview because no sedentary behavior studies were found.

Supplementary File 2 shows the reviews included in the overview (n=27). Reviews were published between 2007[38] and 2013 [16,17,39]. The quality of the original studies was assessed in 16 (60%) reviews,[15,16,18,20,21,26,27,28,31,32,34,36,38-41], and 6 (22%) performed a meta-analysis.[19,26,28,29,34,37]

Among the 27 systematic reviews, 17 did not restrict the type of sedentary behavior in the research question,[15,17,18,21-23,25-28,30-35,39] 8 used only screen-based sedentary behavior,[16,19,20,24,29,37,38,41], and 3 used sitting-time (at work or at leisure).[36,37,40]

In general, the systematic reviews' eligibility criteria were based on age, language, date published, and study design (Supplementary file 3). Physical activity was evaluated as a covariate in 11 (41%) systematic reviews.[15,16,28,29,30,31,33,34,37,40,41] Of those, the proportion of original studies that included physical activity as a covariate ranged between 15%-100% (mean 63%). The information on whether physical activity was assessed objectively or by questionnaire was only available in Edwardson et al. (7 studies with a questionnaire and 1 with an accelerometer)[28], and Ford and Caspersen

(11 studies with a questionnaire and 0 with an accelerometer)[37] systematic reviews (Supplementary file 3).

Methodological Quality

Based on AMSTAR, we assessed the methodological quality of the 27 reviews included in the overview (see Supplementary File 4). For children and adolescents, 6 reviews (46%) scored ≥ 6 points.[15,16,18,20,26,27]. In adults, 5 reviews (62%) scored ≥ 6 points,[28,29,31,32,34] whereas the 3 reviews with unspecified ages (43%) had a total score ≥ 6 points.[38,39,41] Additionally, the quality assessment of the included articles was conducted in 17 (63%) reviews,[15,16,18,20,21,25,27,28,31,32,34-36,38-41] and 16 (60%) used the quality appropriately to formulate conclusions.[15,16,18,20,21,25,27,28,31,32,34-36,38,40,41]

Outcomes

The level of scientific evidence synthesized for each outcome according to age group and sedentary behavior type is shown in the Supplementary file 5.

Mortality

Seven systematic reviews investigated the association between sedentary behavior and mortality in adults.[29-31,33,34,37,40] Consistent findings of prospective studies and studies with high levels of methodological quality suggest that sedentary behavior is

associated with all-cause and cardiovascular mortality, regardless of the level of physical activity and body mass index (BMI).[29,31,33,34,37,40]

In Ford et al.,[37] for each 2-hours of additional sitting time there was a 5% increase in cardiovascular mortality (HR 1.05; 95% CI 1.01-1.09). Grøntved and Hu[29] found that watching television for more than 2 hours per day was associated with a 13% increase in all-cause mortality (RR, 1.13; 95% CI, 1.07–1.18).

According to Wilmot et al.,[34] for adults that spend most of their time engaged in sedentary behaviors (screen-time and sitting time), compared to those who spend very little time engaged in such behaviors, the relative risk for all-cause mortality and cardiovascular mortality is 1.49 (95% CI, 1.14–2.03) and 1.90 (95% CI, 1.36–2.66), respectively. However, most of the studies evaluated by Wilmot et al.[34] were cross-sectional studies that did not employ standardized measures of the time spent in sedentary behavior, which would have allowed the summary measure to have been calculated in the meta-analysis.

Although some systematic reviews have indicated an association between sedentary behavior (leisure-time sitting, television viewing, total and occupational sitting time) and cancer-related mortality,[30,40] others have found no such association.[31,33] However, the latter evaluated the total number of deaths from cancer regardless of the etiology.

Cardiovascular disease

Five systematic reviews investigated the association between sedentary behavior and cardiovascular disease in adults.[29,33,34,37,40] Two of these reviews indicated that there are conflicting results regarding sedentary behavior (occupational and general), in

terms of cardiovascular outcomes,[33,40] underscoring the fact that there have been few studies addressing this topic. More recently, two systematic reviews that included meta-analyses concluded that the results are consistent and show a significant positive association between sedentary behavior (≥2 television hours/day; screen-time and sitting time) and cardiovascular disease, regardless of the level of physical activity, with summary measures of 1.15 (95% CI, 1.06–1.23) and 2.47 (95% CI, 1.44–4.24), respectively.[29,34] In addition, in the most recent meta-analysis, Ford et al.,[37] found that 2 hours/day of screen- time and sitting time were associated with an increase of 5% (HR 1.05; 95% CI 1.01-1.09) and 17% (HR 1.17; 95% CI 1.13-1.20) in cardiovascular events, respectively.

Cancer

Five systematic reviews investigated the association between sedentary behavior and cancer in adults.[30,31,33,35,40] These reviews showed that sedentary behavior (overall sitting time, sitting outside of work, and TV viewing) is associated with an increase in the risk of colorectal,[33,35,40] breast,[30,40] endometrial,[31,33] ovary,[33,40] and prostate cancer.[30] However, conclusions are still based on a limited number of studies, some of which did not consider confounding factors such as BMI and physical activity.[31,33] Additionally, van Uffelen et al.[40] stated that there is no established association between occupational sitting time and renal, prostate, lung or testicular cancer.

Type 2 diabetes

Five systematic reviews concluded that there is a significant and positive association between sedentary behavior and type 2 diabetes in adults, regardless of physical activity level.[29,31,33,34,40] The meta-analysis conducted by Grøntved and Hu[29] found that watching television for more than 2 h per day was associated with a 20% increase in the risk of type 2 diabetes (RR, 1.20; 95% CI, 1.14–1.27). According to Wilmot et al.,[34] adults that spend most of their time engaged in sedentary behavior (screen-time and sitting time), compared to adults who spend very little time engaged in such behavior, are at increased risk of developing type 2 diabetes (RR, 2.12; 95% CI 1.61, 2.78). However, these authors included 5 cross-sectional studies and 5 prospective studies for the summary measure in their meta-analysis. When the meta-analysis included only the prospective studies, the results, although still statistically significant, were attenuated.

Metabolic syndrome and individual cardiovascular risk factors

One systematic review evaluated the association between sedentary behavior and metabolic syndrome;[28] four evaluated the association between sedentary behavior and individual cardiovascular risk factors,[15,18,31,33] and one evaluated both associations.[26]

In children and adolescents, two reviews have been published.[15,26] For Chinapaw et al.,[15] there is insufficient evidence for a longitudinal relationship between sedentary time and blood pressure or blood lipids. In contrast, Tremblay et al.[6] reported that there is longitudinal evidence (studies with moderate quality) linking sedentary behavior

(television, screen-time, and self-reported sedentary behavior) with total cholesterol and blood pressure; however, there was insufficient evidence for metabolic syndrome.

In adults, time spent in sedentary behavior (television viewing and screen-time) is associated with metabolic syndrome, regardless of the level of physical activity.[28] However, the evidence is insufficient for individual cardiovascular risk factors (e.g., blood pressure, blood lipids and cholesterol levels).[31,33]

Obesity, overweight and adiposity

Fourteen systematic reviews examined whether sedentary behavior was associated with body mass index, weight gain, overweight/obesity and adiposity in children, adolescents[15-19,22-27] and adults.[31,33,40]

In a meta-analysis including randomized controlled trails, Tremblay et al.[26] concluded that TV viewing in children and adolescents leads to obesity. Similar conclusions were reported by the following reviews: Marshall et al.,[19] Rey-Lopez et al.,[23] Prentice-Dunn et al.,[22] Costigan et al.,[16] Hoare et al.,[17] and Salmon et al.,[25] despite their lower methodological quality. In preschool children (4-6 years),[27] there was moderate evidence for an association between TV viewing and overweight. Similarly, Leblanc et al.[18] found low- to moderate- quality evidence linking TV viewing with unfavorable measures of adiposity. Finally, according to Chinapaw et al.[15] insufficient evidence for a longitudinal positive relationship between ‘sedentary time’ – mainly TV viewing – and adiposity exist. The obesogenic effect of sedentary behavior may be mediated by unhealthy dietary behaviors[21,24] and lower physical activity levels.[24]

In contrast, in adults, the obesogenic effect of sedentary behavior is not supported by observational studies. For Thorp et al.[33] limited evidence for a longitudinal relationship exists between sedentary behavior, weight gain, and risk of obesity. Similarly, insufficient evidence was concluded for body weight–related measures in Proper et al.[31] Finally, in van Uffelen et al. , "prospective studies failed to confirm a causal relationship"[40].

Mental health

Few systematic reviews have examined whether sedentary behavior is associated with mental disorders in children,[16,17,26] and with mental[33] and depressive disorders in adults.[31,32,39]

In children and adolescents, sedentary behavior (screen time) was associated with depression; however, evidence was based on cross-sectional studies.[16,17,26] In adults, some reviews reported an association between sedentary behavior (television and other sedentary behaviors) and depressive symptoms[32,33] and postnatal depressive symptoms,[39] also based on cross-sectional studies.

Musculoskeletal disorders

Four systematic reviews investigated the association between sedentary behavior and musculoskeletal disorders.[16,36,38,41] In children, there is insufficient evidence on the association between exposure to screen-based sedentary behavior and musculoskeletal[16] and low back pain.[36] Similarly, for adults, there is limited evidence on the association between sedentary behavior (occupational sitting; computer

use; sedentary behavior and prolonged sitting-time during leisure; and total sitting time) and low back pain, neck pain, shoulder pain, hand pain and arm pain.[36,38,41]

Other Behaviors

Other systematic reviews analyzed whether sedentary behavior was associated with: physical activity,[19,24] aggression,[20] unhealthy dietary intake (e.g., between meal snacks, sweets and beverages),[21,24,25] and pro-social behaviors[26] in children. In adults, smoking,[25] less leisure time physical activity,[19,24] alcohol consumption and eating have all been examined in relation to sedentary behavior.[25]

In children with emotional and environmental difficulties, there is insufficient evidence for the association between television viewing and aggressiveness.[20] Studies of children, in general, have demonstrated a significant inverse relationship, albeit a weak one, between television viewing and engaging in physical activity.[19,24] In such studies, television viewing was associated with lower self-esteem and pro-social behaviors.[26] In addition, Pearson and Biddle[21] conducted a review in which they concluded that sedentary behavior, predominantly screen time, is associated with unhealthy eating habits (alcohol consumption and eating behavior in adults) in adults, adolescents, and children, although most of the articles evaluated were cross-sectional studies.

Other outcomes

Systematic reviews have investigated the association between sedentary behavior and other health outcomes, such as bone loss,[26] psychosocial and motor

dysfunction,[18,26] poor academic performance and cognitive development,[18,26] physical fitness,[15,26] and symptomatic gallstone disease.[33]

Two recent systematic reviews (with no risk of serious bias) found a significant inverse association between television viewing time and academic performance, as measured by IQ, grades/grade point average, and performance on standardized tests.[18,26] Television viewing was also associated with low cognitive performance, worse reading comprehension, low math scores, less classroom engagement, worse comprehension, low memory, reduced attention and number of vocalizations, and language delay.[18]

Other studies showed that, in children, increased television viewing time was associated with poor psychosocial health (e.g., poor social behaviors and low self-esteem).[18,25] Studies with moderate quality indicated an association between sedentary behavior (watching TV and playing computer games) and physical fitness (including general physical fitness, aerobic power and neuromotor) in children and youth,[15,26] regardless of the level of physical activity.

There is insufficient data to draw any conclusions regarding the relationship between sedentary behavior and bone mass[15] in children and symptomatic gallstone disease in adults.[33]

Use of Causative Language

Of the 27 reviews included in this overview, only Tremblay et al.[26] made a correct causal claim about sedentary behavior and obesity in children (Supplementary File 6).[23,26] Because conclusions were based on observational studies, the majority of the reviews provided greater inferential strength than their review warranted. Taken

together, most of the researchers were aware of the limitations presented in each review to establish the best scientific evidence.

OVERALL CONCLUSIONS

The present overview summarizes the current knowledge about the role of sedentary behavior on human health. The main limitations of this overview were that we drew conclusions based only on systematic reviews of observational studies. Unfortunately, we identified very few systematic reviews of RCTs in our initial research strategy. In addition, the main focus of the RCT reviews were only to analyze the efficacy of interventions to reduce sedentary behavior and/or the effect on short-term health outcomes.[48,49]

It is important to highlight that the observational evidence between sedentary behavior and different health outcomes reported in this overview is complex, depending on the type of sedentary behavior and the age groups studied (Supplementary file 5).

In children and adolescents, there is strong evidence of a relationship between sedentary behavior (based on TV and screen-time) and obesity. Moreover, we found moderate evidence for blood pressure and total cholesterol, self-esteem, social behavior problems, physical fitness and academic achievement (based on TV and screen-time).

In adults, we found strong evidence of a relationship between sedentary behavior and all-cause mortality, fatal and non-fatal cardiovascular disease (based on TV viewing, screen-time and sitting time), type 2 diabetes (TV viewing and screen-time) and metabolic syndrome (based on TV viewing, screen-time, sitting time and objectively measured sedentary time). In addition, there is moderate evidence for incidence rates of

ovarian (sitting time), colon (TV viewing) and endometrial cancers (sitting outside of work and overall sitting) and type 2 diabetes (sitting time).

Finally, for certain health outcomes in adults (e.g., cancer mortality, incidence of breast cancer, colorectal cancer and ovarian cancer, individual cardiovascular risk factors, depressive symptoms, musculoskeletal disorders, health behaviors symptomatic gallstone disease), children and adolescents (e.g., metabolic syndrome, some individual cardiovascular, mental health, musculoskeletal, other health behaviors, bone mass, motor dysfunction) uncertainty remains, and thus, further studies are needed.

PERSPECTIVES

Future directions for original studies

Reviews included a predominance of cross-sectional studies, which do not allow us to infer causality between variables. Although prospective studies with high methodological quality may provide better insight of the role of sedentary behavior on human health, residual confounding may still exist. Ideally, randomized controlled trials should be conducted to confirm deleterious effects attributed to some sedentary behaviors. However, a high-quality randomized controlled trial designed to analyze the effect of sedentary behavior on endpoint health outcomes may be unfeasible because of its high cost and reduced compliance with the intervention. Nonetheless, other epidemiologic study designs (Mendelian randomization,[50] twin studies[51] and high quality observational longitudinal studies with at least three observations for exposure and outcome per individual)[52] may also provide evidence for a causal link.

Moreover, caution is advised when using only one type of sedentary behavior to establish relationships between sedentary behavior and health outcomes because effects vary substantially among exposures. To increase the current knowledge of sedentary behavior, we also need better quality exposure measurements. That is, future studies must incorporate emergent objective methods of sedentary behavior measurement (i.e., geolocation data combined with acceleration signals in mobile phones, small video cameras, and inclinometers).[53] In this sense, it is likely that including more accurate tools to evaluate sedentary behavior will enhance the measure of effect.[54] Further information regarding methods of measurement in epidemiological studies of sedentary behavior have been described in detail elsewhere.[53] Finally, the evaluation of confounders (i.e., physical activity) should also receive special attention; otherwise, residual confounding may still be present.

Future directions for systematic reviews

From our point of view, future systematic reviews should assess the quality of the original articles and make conclusions based on it. Other AMSTAR items that were infrequently performed/reported and merit future considerations were: prior design of the systematic review, the use of two independent reviewers and data extractors, inclusion of grey literature, list of included and excluded articles selected, evaluation of heterogeneity and publication bias. Systematic reviews of observational studies should also detail how confounding variables (i.e., physical activity) were assessed in each original study. In addition, the main limitations involving meta-analysis of observational

studies (i.e., different measurements of exposure and outcomes, heterogeneity, confounding and bias between studies) should be rigorously considered.[55]

Finally, no systematic reviews have been exclusively performed in elderly individuals. Therefore, we encourage future investigations of sedentary behavior in this age group because they spend most of their daily time in sedentary activities.[12,13]

Figure 1: Preferred Reporting Items for Systematic Reviews flow diagram of the studies included in our overview.

SUPPORTING INFORMATION

Supplementary file 1 – Search strategy

Supplementary file 2 - Characteristics of the systematic reviews examining the relationship between sedentary behavior and health outcomes

Supplementary file 3 - Eligibility criteria and extraction of physical activity adjustment within the systematic reviews

Supplementary file 4 - Methodological quality assessment of systematic reviews

Supplementary file 5 – Level of scientific evidence for associations between sedentary behaviors and health outcomes, by age group and type of sedentary behavior.

Supplementary file 6 - Aims, main results and use of causative language in systematic reviews of sedentary behavior and health outcomes

Prisma Checklist

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SUPPLEMENTARY FILE 1

SEARCH STRATEGY

Search strategy in 02nd September 2013
Total – 1044
Removing Duplicate articles - 893

Medline – 424 articles
((((physical inactivity)) OR (physical activity))) AND ((((((((((((sedentary behavior)) OR (sedentary lifestyles)) OR (sedentary time)) OR (sitting time)) OR (tv viewing)) OR (television viewing)) OR (tv watching)) OR (television watching)) OR (driving)) OR ("screen based")) OR (video game)) OR (computer)) OR ("screen time")) Filters activated: Systematic Reviews, Meta-Analysis

Detailed search
((("physical examination"[MeSH Terms] OR ("physical"[All Fields] AND "examination"[All Fields]) OR "physical examination"[All Fields] OR "physical"[All Fields]) AND inactivity[All Fields]) OR ("motor activity"[MeSH Terms] OR ("motor"[All Fields] AND "activity"[All Fields]) OR "motor activity"[All Fields] OR ("physical"[All Fields] AND "activity"[All Fields]) OR "physical activity"[All Fields])) AND ((((((((((((sedentary[All Fields] AND ("behaviour"[All Fields] OR "behavior"[MeSH Terms] OR "behavior"[All Fields])) OR ("sedentary lifestyle"[MeSH Terms] OR ("sedentary"[All Fields] AND "lifestyle"[All Fields]) OR "sedentary lifestyle"[All Fields] OR ("sedentary"[All Fields] AND "lifestyles"[All Fields]) OR "sedentary lifestyles"[All Fields])) OR (sedentary[All Fields] AND ("time"[MeSH Terms] OR "time"[All Fields]))) OR (sitting[All Fields] AND ("time"[MeSH Terms] OR "time"[All Fields]))) OR (tv[All Fields] AND viewing[All Fields])) OR (("television"[MeSH Terms] OR "television"[All Fields]) AND viewing[All Fields])) OR (tv[All Fields] AND watching[All Fields])) OR (("television"[MeSH Terms] OR "television"[All Fields]) AND watching[All Fields])) OR ("automobile driving"[MeSH Terms] OR ("automobile"[All Fields] AND "driving"[All Fields]) OR "automobile driving"[All Fields] OR "driving"[All Fields])) OR "screen based"[All Fields]) OR ("video games"[MeSH Terms] OR ("video"[All Fields] AND "games"[All Fields]) OR "video games"[All Fields] OR ("video"[All Fields] AND "game"[All Fields]) OR "video game"[All Fields])) OR ("computers"[MeSH Terms] OR "computers"[All Fields] OR "computer"[All Fields])) OR "screen time"[All Fields])

Psychinfo – 39 articles
edentary behavior OR sedentary lifestyles OR sedentary time OR sitting time OR tv viewing OR television viewing OR tv watching OR television watching OR driving OR "screen based" OR video game OR computer OR "screen time""

web of science – 333 articles

(physical inactivity OR physical activity) AND (sedentary behavior OR sedentary lifestyles OR sedentary time OR sitting time OR tv viewing OR television viewing OR tv watching OR television watching OR driving OR "screen based" OR video game OR computer OR "screen time") AND (systematic review OR meta-analysis OR evidence-base medicine)

embase – 248 articles

#1.15	**#1.14** AND (**'evidence based medicine'**/de OR **'meta analysis'**/de OR **'systematic review'**/de)
#1.14	**#1.13** AND **'review'**/it
#1.13	**#1.8** AND **#1.12**
#1.12	**#1.1** OR **#1.2** OR **#1.3** OR **#1.4** OR **#1.5** OR **#1.6** OR **#1.7** OR **#1.9** OR **#1.10** OR **#1.11**
#1.11	**'driving car'**/exp OR **'driving car'**
#1.10	**'sitting time'**
#1.9	**'screen based'**
#1.8	**'physical activity'**/exp OR **'physical activity'** OR **'physical inactivity'**/exp OR **'physical inactivity'**
#1.7	**'video games'**/exp OR **'video games'**
#1.6	**'television viewing'**/exp OR **'television viewing'**
#1.5	**'sedentary behavior'**
#1.4	**'sedentary time'**
#1.3	**'sitting position'**/exp OR **'sitting position'**
#1.2	**'sedentary activity'**/exp OR **'sedentary activity'**
#1.1	**'sedentary lifestyle'**/exp OR **'sedentary lifestyle'**

SUPPLEMENTARY FILE 2 Characteristics of the systematic reviews examining the relationship between sedentary behaviour and health outcomes.

Author	Year	Age group	Type of Sedentary behaviour‡	Outcome measure	Meta-analysis	Quality assessment
Children and Adolescents						
Chinapaw *et al*[15]	2011	< 18 years	no restriction	Biomedical health indicators	No	Yes
Costigan *et al*[16]	2013	12-18 years	Screen-based sedentary behavior	Health Indicator (Physical, psychosocial, and/or behavioural)	No	Yes
Hoare *et al*[17]	2013	10-19 years	no restriction	Depression	No	No
LeBlanc *et al*[18]	2012	0–4 years	no restriction	Adiposity, bone mass, motor development, psychosocial health, cognitive development, cardiometabolic health	No	Yes
Marshall *et al*[19]	2008	3–18 years	Television viewing, video/computer game use	Increased body fat and physical activity	Yes	No
Mitrofan *et al*[20]	2008	< 18 years	Television viewing and videogame playing	Childhood aggression	No	Yes
Pearson and Biddle[21]	2011	< 11 years; 12–18 years; and > 18 years	no restriction	Dietary intake	No	Yes
Prentice-Dunn and Prentice-Dunn[22]	2012	2–19 years	no restriction	Obesity	No	No
Rey-López et al[23]	2008	2-18 years	no restriction	Overweight and obesity	No	No
Rossi *et al*[24]	2010	6–19 years	Television viewing	Dietary intake and obesity	No	No
Salmon *et al*[25]	2011	0-18 years	no restriction	Obesity, unhealthy diet, tobacco use, drug, and alcohol use, socio-cognitive outcomes, between meal snacking, depression.	No	No
Tremblay *et al*[26]	2012	5–17 years	no restriction	Body composition, physical fitness, metabolic syndrome, cardiovascular risk, self-esteem, pro-social behaviour, academic performance	Yes	Yes
Velde *et al*[27]	2012	4–6 years	no restriction	Obesity	No	Yes

Adults						
Edwardson *et al*[28]	2012	> 18 years	no restriction	Metabolic syndrome	Yes	Yes
Grontved and Hu[29]	2011	> 18 years	Television viewing	Type 2 diabetes, (fatal or non-fatal) cardiovascular disease, and all-cause mortality	Yes	No
Lynch *et al*[30]	2010	> 18 years	no restriction	Colorectal, endometrial, ovarian, and prostate cancer risk; cancer mortality; and weight gain	No	No
Pearson and Biddle[21]	2011	< 11 years; 12–18 years; and > 18 years	no restriction	Dietary intake	No	Yes
Proper *et al*[31]	2011	> 18 years	no restriction	Increased BMI, obesity, increased waist circumference, mortality, type 2 diabetes, cardiovascular risk factors, and endometrial cancer	No	Yes
Teychenne *et al*[32]	2010	18-60	no restriction	Depression	No	Yes
Thorp *et al*[33]	2011	> 18 years	no restriction	Mortality, disease incidence, obesity, weight gain, cardiometabolic biomarkers	No	No
Wilmot *et al*[34]	2012	> 18 years	no restriction	Type 2 diabetes, cardiovascular disease, and all-cause mortality	Yes	Yes
Unspecified ages						
Boyle[35]	2012	Unspecified age group	no restriction	Colon cancer	No	No
Chen *et al*[36]	2009	Unspecified age group	Prolonged sitting at work and during leisure time	Low back pain	No	Yes
Ford and Caspersen[37]	2012	Unspecified age group	Screen-time and sitting time	Fatal and non-fatal Cardiovascular disease	Yes	No
IJmker *et al*[38]	2007	Unspecified age group	Occupational computer use	Hand-arm and neck-shoulder symptoms and disorders	No	Yes
Teychenne et al.[39]	2013	Unspecified age group	no restriction	Postnatal Depressive Symptoms	No	Yes
van Uffelen *et al*[40]	2010	Unspecified age group	Occupational sitting	BMI, cancer, cardiovascular disease, type 2 diabetes, and mortality	No	Yes
Waersted *et al*[41]	2010	Unspecified age group	Computer work	Neck and upper extremity disorders (except carpal tunnel syndrome)	No	Yes

‡For review articles evaluating unspecified sedentary behaviours, all sedentary behaviours were collectively defined as "no restriction".

SUPPLEMENTARY FILE 3 Eligibility criteria and extraction of physical activity adjustment within the systematic reviews.

Author	Inclusion Criteria	Exclusion Criteria	Extraction Physical Activity as an Adjustment	How Many Studies Adjusted How an Physical Activity was Assessed
Children and Adolescents				
Chinapaw *et al* [15]	- Prospective studies – relationship between sedentary behaviour and health indicators. - Full-text articles published in English	N/A	Yes	Yes - (14/31) = 45% Questionnaire: N/A Objectively: N/A
Costigan *et al* [16]	- Adolescent girls aged 12 e 18 years - Examined in adolescent girls or separately by gender - Cross-sectional, longitudinal, or experimental study design - Assessed leisure-time screen- based sedentary behavior and at least one health indicator	- Conference abstracts, dissertations, theses and articles in non-peer-reviewed journals - Screen-time in an educational context and; considered the content viewed - Active electronic gaming	Yes	Yes - (16/33) = 49% Questionnaire: N/A Objectively: N/A
Hoare *et al* [17]	- Young people between 10–19 years	- Particular groups (e.g. disability) and/or pilot or feasibility studies	N/A	N/A
LeBlanc *et al* [18]	- Sedentary behaviour time and health indicator in the early years (infants: 1 month – 1.0 years; toddlers: 1.1–3.0 years; preschoolers: 3.1– 4.99 years) - RCT, quasi-experimental, intervention, prospective cohort, or any study that has either a comparison group or a follow-up period	- Papers published in other languages than English or French - Active electronic gaming	N/A	N/A
Marshall *et al* [19]	- Participants less than 18 y of age - Published in English in peer-reviewed journals	N/A	N/A	N/A
Mitrofan *et al* [20]	- Quantitative and qualitative studies - Associations between aggressive content and amount of television viewing and video game playing and aggression in children and young people with behavioural and emotional difficulties	- Studies examining aggression-related phenomena (e.g. thoughts, feelings or mood)	N/A	N/A
Pearson and Biddle[21]	- Children ≤11 years; Adolescents 12-18 years; >18 years - At least one measure of sedentary behavior - Observational studies - Published up to January 2010	- Experimental Studies	N/A	N/A
Prentice-Dunn and Prentice-Dunn[22]	- Cross-sectional studies published between 2000–2010 - Children: ages 2–19	- Fewer than 100 subjects were excluded	N/A	N/A
Rey-López et al[23]	- Children between 2-18 years old - Published between 1990-2007	N/A	N/A	N/A
Rossi *et al* [24]	- Open-access full-published articles - Published in English and Portuguese. - Children between 6 to 19 years - Published between 2000-2010.	- Communications, reviews, and particular groups (e.g. disability)	N/A	N/A
Salmon *et al* [25]	- Children and adolescents: ages 0–18	N/A	N/A	N/A
Tremblay *et al* [26]	- Children and adolescents: ages 5–18 - All study designs	- Population based studies a minimum sample size of 300 participants; RCTs, and intervention with at least 30 participants. - Active electronic gaming - Sedentary behaviour as 'failing to meet physical activity guidelines'	N/A	N/A
Velde *et al* [27]	- Prospective studies - Children aged 4–6 years at baseline - Anthropometric measurements - Only full-text papers published in English were included.	- Studies addressing nutrition disorders, - Reporting parental behaviours (e.g. feeding practices) - Studies including a selected group of children	N/A	N/A

Adults				
Edwardson *et al*[28]	- Cross sectional or prospective design; - Adults ≥18 years of age; - Self-report or objective measure of time spent sedentary; - Include an outcome measure of metabolic syndrome; and (5) - Published in English	- Sedentary behaviour as 'failing to meet physical activity guidelines'	Yes	Yes - (8/10) = 80% Questionnaire: 7 studies Objectively: 1 study
Grontved and Hu[29]	- Published in the English - Prospective design (cohort, case-cohort, and nested case-control) - Population that was healthy at baseline - Had estimates of relative risk (RR) or OR with 95% CIs	N/A	Yes	Yes - (7/8) = 88% Questionnaire: N/A Objectively: N/A
Lynch *et al*[30]	- Written in English between 1980 – June 2010 - Non-pregnant adults (- Sedentary behavior as an independent variable from physical activity	- Sedentary behaviour as 'failing to meet physical activity guidelines'	Yes	Yes - (14/18) = 78% Questionnaire: N/A Objectively: N/A
Pearson and Biddle[21]	- Children ≤11 years; Adolescents 12-18 years; >18 years - At least one measure of sedentary behavior - Observational studies - Published up to January 2010	- Experimental Studies	N/A	N/A
Proper *et al*[31]	- Prospective Design - Healthy population>18 years	N/A	Yes	Yes - (12/19) = 63% Questionnaire: N/A Objectively: N/A
Teychenne *et al*[32]	- Both observational and experimental - Healthy adults – 18 – 60 years - Valid indicator risk of depression	Abstract and dissertations	N/A	N/A
Thorp *et al*[33]	- Longitudinal Studies - Adults >18 years - Sedentary behavior and health outcomes	N/A	Yes	Yes - (34/48) = 71% Questionnaire: N/A Objectively: N/A
Wilmot *et al*[34]	- Cross-sectional or prospective design; - Adults ≥18 years of age; - Self- reported or objective measure of time spent sedentary; - Report data on a relevant health outcome	- Sedentary behaviour as 'failing to meet physical activity guidelines'	Yes	Yes - (10/18) = 56% Questionnaire: N/A Objectively: N/A

Unspecified ages				
Boyle[35]	Relationship Sedentary behavior and Cancer	N/A	N/A	N/A
Chen *et al*[36]	- Sitting and low back pain studies - Cohort or Case-control	- Specific spinal condition	N/A	N/A
Ford and Caspersen[37]	- Sedentary behavior and mortality - Adults Publications written in English		Yes	Yes - (11/11) = 100% Questionnaire: 11 Objectively: 0
IJmker *et al*[38]	- Study population computer workers and syndromes, signs or symptoms related to pain or discomfort in hand, arm, shoulder or neck; - A risk estimate of the association - Longitudinal study - Full-text, peer-reviewed article, written in English, Dutch or German	Experimental studies, abstracts and letters	N/A	N/A
Teychenne et al.[39]	- Observational study	- Dissertations and abstracts	N/A	N/A
van Uffelen *et al*[40]	- Adults - Occupational sitting time and the relationship with health outcomes - Only full-texts	N/A	Yes	Yes - (19/43) = 44% Questionnaire: N/A Objectively: N/A
Waersted *et al*[41]	- Working age population - computer sitting time and the relationship with musculoskeletal disorders (objective examination) - Only full-texts	- Effects of intervention on musculoskeletal disorders related to computer use	Yes	Yes - (4/22) = 15% Questionnaire: N/A Objectively: N/A

‡For review articles evaluating unspecified sedentary behaviours, all sedentary behaviours were collectively defined as "no restriction".

SUPPLEMENTARY FILE 4: Methodological quality assessment of systematic reviews

	Methodological Quality Assessment of the included studies Systematic Reviews - AMSTAR Itens											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Rating**
Children and Adolescents												
Chinapaw et al[15]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	7
Costigan et al[16]	Yes	No	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	6
Hoare et al[17]	Yes	No	No	No	Yes	Yes	No	No	N/A	No	Yes	4
LeBlanc et al[18]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	8
Marshall et al[19]	Yes	No	Yes	No	No	No	No	No	Yes	No	No	3
Mitrofan et al[20]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	N/A	No	No	7
Pearson and Biddle[21]	Yes	No	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	5
Prentice-Dunn and Pre	Yes	No	No	No	No	Yes	No	No	N/A	No	No	2
Rey-López et al[23]	Yes	No	No	No	No	Yes	No	No	N/A	No	Yes	3
Rossi et al[24]	Yes	No	Yes	No	No	Yes	No	No	N/A	No	No	3
Salmon et al[25]	Yes	No	Yes	No	No	No	No	No	N/A	No	Yes	3
Tremblay et al[26]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	10
Velde et al[27]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	7
Adults												
Edwardson et al[28]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	9
Grontved and Hu[29]	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes	Yes	6
Lynch et al[30]	Yes	No	Yes	No	No	Yes	No	No	N/A	No	Yes	4
Pearson and Biddle[21]	Yes	No	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	5
Proper et al[31]	Yes	No	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	6
Teychenne et al[32]	Yes	No	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	6
Thorp et al[33]	Yes	No	Yes	No	No	Yes	No	No	N/A	No	Yes	4
Wilmot et al[34]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	9
Unspecified ages												
Boyle[35]	Yes	No	Yes	No	No	Yes	No	No	N/A	No	No	3
Chen et al[36]	Yes	No	Yes	No	No	No	Yes	Yes	N/A	Yes	No	5
Ford and Caspersen[37]	Yes	No	No	No	No	Yes	No	No	Yes	No	Yes	4
IJmker et al[38]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	7
Teychenne et al.[39]	Yes	No	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	6
van Uffelen et al[40]	Yes	No	Yes	No	No	No	Yes	Yes	N/A	No	Yes	5
Waersted et al[41]	Yes	No	Yes	No	No	Yes	Yes	Yes	N/A	No	Yes	6
TOTAL	27	8	23	2	2	23	16	16	7	5	21	
%	100	30%	85%	7%	7%	85%	59%	59%	26%	18%	28%	

SUPPLEMENTARY FILE 5 – Level of scientific evidence for associations between sedentary behaviors and health outcome, by age group and type of sedentary behavior.

OUTCOMES	CHILDREN	ADOLESCENTS	ADULTS
Mortality			
All-cause mortality	No evidence	No evidence	Strong Evidence[1,2,3]
CVD mortality	No evidence	No evidence	Strong Evidence[1,2,3]
Cancer Mortality	No evidence	No evidence	No Evidence[1,3,4]
Cardiovascular Diseases	No evidence	No evidence	Strong Evidence[1,2,3] Insufficient Evidence[4]
Cancer			
Breast	No evidence	No evidence	Insufficient Evidence[4]
Colorectal	No evidence	No evidence	Insufficient Evidence[4]
Colon			Moderate Evidence[6]
Endometrial	No evidence	No evidence	Moderate Evidence[6]
Ovarian	No evidence	No evidence	Moderate Evidence[6] Insufficient Evidence[4]
Prostate	No evidence	No evidence	Insufficient Evidence[6]
Type 2 Diabetes	No evidence	No evidence	Strong Evidence[1,2] Moderate Evidence[3] Insufficient Evidence[4]
Metabolic Syndrome	Insufficient Evidence[1,2,3]	Insufficient Evidence[1,2,3]	Strong Evidence[1,2,3,5]
Individual Cardiovascular Risk Factors			
Blood Pressure	Moderate Evidence[1]	Moderate Evidence[1]	Insufficient Evidence[1]
Total Cholesterol	Moderate Evidence[1]	Moderate Evidence[1]	Insufficient Evidence[1]
HbA1	Insufficient Evidence[1,2,3]	Insufficient Evidence[1,2,3]	Insufficient Evidence[1]
Fasting Insulin	Insufficient Evidence[1,2,3]	Insufficient Evidence[1,2,3]	Insufficient Evidence[2]
Insulin resistance	Insufficient Evidence[1,2,3]	Insufficient Evidence[1,2,3]	Insufficient Evidence[2]
Leptin	No Evidence	No Evidence	Insufficient Evidence[1]
Fibrinogen	No Evidence	No Evidence	Insufficient Evidence[1]
C-peptide	No Evidence	No Evidence	Insufficient Evidence[1]
Obesity	Strong Evidence[1,2]	Strong Evidence[1,2]	Insufficient Evidence[1,4]
Mental Health			
Self-Esteem	Moderate Evidence[1,2]	Moderate Evidence[1,2]	No Evidence
Depressive Symptoms	No Evidence	No Evidence	Insufficient Evidence[3]
Postnatal Depression	No Evidence	No Evidence	Insufficient Evidence[3,4]
Cognitive Aspects	Insufficient Evidence[1]	No Evidence	No Evidence

Musculoskeletal	No Evidence	Insufficient Evidence[2]	Insufficient Evidence[4]
Other Behaviors (PA, diet, alcohol consumption)	Insufficient Evidence[1]	Insufficient Evidence[1]	Insufficient Evidence[1]
Social Behavior Problems	Moderate Evidence[1,2]	Moderate Evidence[1,2]	No Evidence
Other Health Outcomes			
Bone Mass	Insufficient Evidence[3]	Insufficient Evidence[3]	No Evidence
Motor Dysfunction	Insufficient Evidence[1]	Insufficient Evidence[1]	No Evidence
Physical Fitness	Moderate Evidence[1,2]	Moderate Evidence[1,2]	No Evidence
Academic Achievement	Moderate Evidence[1,2]	Moderate Evidence[1,2]	No Evidence
Symptomatic gallstone disease	No Evidence	No Evidence	Insufficient Evidence[5]

SUPPLEMENTARY FILE 6: Aims, main results and use of causative language in systematic reviews of sedentary behaviour and health outcomes. *

Children and adolescentes	
Costigan et al.[11]	Aim: To investigate the association between recreational screen-based sedentary behavior and the physical, behavioral, and psychosocial health indicators for adolescent girls. Main results: Screen-based sedentary behavior *is associated* with a range of adverse health consequences, but additional longitudinal studies are needed to better understand the health impacts. Causative language: Acceptable.
Hoare et al.[12]	Aim: To identify and evaluate the empirical literature reporting the relationships between obesogenic risk factors (physical activity, sedentary behaviour, diet and weight status) and depression in adolescents. Main results: *Relationships* were found between lack of physical exercise, heightened sedentary behaviour, poor diet quality, obese or overweight and depression in adolescence. Causative language: Acceptable.
Rey-López et al.[17]	Aim: To review published studies about sedentary behaviour among children and adolescents and analyse its specific influences on body composition. Main results: The *causes* of excessive weight gain in children are multi-factorial [13]. With regard to environmental factors, sufficient evidence exists to recommend setting a limit to the time spent watching TV, especially by young children. Causative language: Qualified casual. Main results based on randomized controlled trials: No.
Salmon et al.[19]	Aim: To examine the evidence of the relationship between sedentary behavior and health risk indicators. Main results: A growing body of *evidence supports the development of public health recommendations* to limit the time spent in screen-based behaviors. Causative language: Qualified causal. Main results based on randomized controlled trials: No.
Chinapaw et al.[20]	Aim: To describe the prospective relationship between childhood sedentary behaviour and health indicators. Main results: We found insufficient evidence for a longitudinal positive *relationship* between 'sedentary time' – mainly TV viewing – and body mass index (BMI) and more specific indicators of fat mass. One high quality and two low quality studies found a significant inverse *relationship* between sedentary time – mainly TV viewing – and aerobic fitness, leading to moderate evidence for this inverse relationship. There was insufficient evidence for a longitudinal *relationship* between sedentary time and blood pressure, blood lipids or bone mass. Our systematic review suggests that there is moderate evidence for a longitudinal inverse *relationship* between screen time and aerobic fitness during childhood. Causative language: Acceptable.
LeBlanc et al.[21]	Aim: To present the best available evidence on the threshold of sedentary behaviour associated with healthy measures of adiposity, bone health, motor skill development, psychosocial health, cognitive development, and cardiometabolic health indicators in infants, toddlers, and preschoolers. Main results: This review found low- to moderate- quality evidence to suggest that increased television viewing is *associated* with unfavourable measures of adiposity and decreased scores on measures of psychosocial health and cognitive development. Causative language: Acceptable.

Marshall et al.[22]	Aim: To review the empirical evidence of associations between television (TV) viewing, video/computer game use and (a) body fatness, and (b) physical activity. Main results: A statistically significant *relationship* exists between TV viewing and body fatness among children and youth although it is likely to be too small to be of substantial clinical relevance. Causative language: Acceptable.
Mitrofan et al.[23]	Aim: To collate and determine the quality of research on associations between aggressive content and amount of television viewing or video games playing and aggression in children and young people with behavioural and emotional difficulties. Main results: This systematic review found insufficient, contradictory and methodologically flawed evidence on the association between television viewing and video game playing and aggression in children and young people with behavioural and emotional difficulties. Causative language: Acceptable.
Pearson and Biddle[24]	Aim: To review whether dietary intake is associated with sedentary behavior in young people and adults. Main results: The association drawn mainly from cross-sectional studies is that sedentary behavior, usually assessed as screen time and predominantly TV viewing, is *associated* with unhealthy dietary behaviors in children, adolescents, and adults. Causative language: Acceptable.
Prentice-Dunn and Prentice-Dunn[25]	Aim: To examine associations of physical activity (PA) and sedentary behavior to childhood overweight and obesity in cross-sectional studies from the last 10 years. Main results: In general, sedentary behaviors were positively associated with weight status. Causative language: Acceptable.
Rossi et al.[26]	Aim: To identify the influence that watching television has on food intake and obesity in children and adolescents. Main results: Since time spent watching television is associated with unhealthy food habits and reduced levels of physical activity, it becomes an important factor in the promotion of obesity in children and adolescents. Causative language: Acceptable.
Tremblay et al.[27]	Aim: To determine the relationship between sedentary behaviour and health indicators in school-aged children and youth aged 5-17 years. Main results: In particular, the evidence suggests that daily TV viewing in excess of 2 hours is associated with reduced physical and psychosocial health, and that lowering sedentary time *leads to* reductions in BMI. Causative language: Causal. Main results based on randomized controlled trials: Yes.
Te Velde et al.[28]	Aim: To systematically identify dietary, physical activity and sedentary behaviours in preschool children (4–6 years of age) that are prospectively related to overweight or obesity later in childhood. Main results: Strong evidence was found for an inverse *association* between total physical activity and overweight. Moderate evidence was observed for a positive *association* between television viewing and overweight. Because of the heterogeneity in the assessed dietary behaviours, insufficient evidence was found for an *association* between dietary intake or specific dietary behaviours and overweight. Causative language: Acceptable.

Adults

Teychenne et al.[29]	Aim: To investigate the effect of SB on the risk of depression in adults. Main results: Evidence for the relationship between SB and risk of depression in adults is limited by methodological weaknesses. However, on balance, this review suggests that SB is associated with an increased risk of depression. Causative language: Acceptable.
Edwardson et al.[30]	Aim: To quantify the association between sedentary behavior and the metabolic syndrome in adults using meta-analysis. Main results: People who spend higher amounts of time in sedentary behaviours have *greater odds* of having metabolic syndrome. Causative language: Acceptable.
Grontved and Hu[31]	Aim: To perform a meta-analysis of all prospective cohort studies to determine the association between TV viewing and risk of type 2 diabetes, fatal or nonfatal cardiovascular disease, and all-cause mortality. Main results: Prolonged TV viewing was *associated* with increased risk of type 2 diabetes, cardiovascular disease, and all-cause mortality. Causative language: Acceptable.
Proper et al.[32]	Aim: To systematically review the literature as to the relationship between sedentary behaviors and health outcomes considering the methodologic quality of the studies. Main results: This review of prospective studies showed moderate evidence for an independent *relationship* between sedentary time and type 2 diabetes. In addition, strong evidence was found for sedentary behavior to be *related* to all-cause and CVD mortality, but not for mortality from cancer. Causative language: Acceptable.
Thorp et al.[34]	Aim: To systematically review and provide an informative synthesis of findings from longitudinal studies published since 1996 reporting on relationships between self-reported sedentary behavior and device-based measures of sedentary time with health-related outcomes in adults. Main results: Findings indicate a consistent *relationship* of self-reported sedentary behavior with mortality and with weight gain from childhood to the adult years. Causative language: Acceptable.
Lynch et al.[35]	Aim: To evaluate the research on sedentary behavior and cancer, to summarize possible biological pathways that may underlie these associations, and to propose an agenda for future research. Main results: Sedentary behavior was *associated* with increased colorectal, endometrial, ovarian, and prostate cancer risk; cancer mortality in women; and weight gain in colorectal cancer survivors. Causative language: Acceptable.
Pearson and Biddle[24]	Aim: To review whether dietary intake is associated with sedentary behavior in young people and adults. Main results: The association drawn mainly from cross-sectional studies is that sedentary behavior, usually assessed as screen time and predominantly TV viewing, is *associated* with unhealthy dietary behaviors in children, adolescents, and adults. Causative language: Acceptable.
Wilmot et al.[36]	Aim: To examine the association of sedentary time with diabetes, cardiovascular disease and cardiovascular and all-cause mortality. Main results: Sedentary time is *associated* with an increased risk of diabetes, cardiovascular disease and cardiovascular and all-cause mortality; the strength of the association is most consistent for diabetes. Causative language: Acceptable.

Unspecified ages

Boyle[37]	Aim: There is also emerging evidence that sedentary behavior, or too much sitting, may be a distinct risk factor for colon cancer that acts independently of physical activity. The aim of this review is to summarize the research that has investigated this issue. Main results: Despite these methodological problems, the research conducted in this area so far indicates that sedentary behavior *may be* a risk factor for colon cancer, independently of physical activity. Causative language: Qualified causal.
Ford and Caspersen[38]	Aim: To examine the relationship between sedentary behaviour and cardiovascular morbidity and mortality using prospective observational studies conducted largely during the past decade. Main results: The majority of prospective studies of screen time and sitting time has shown that greater sedentary time is *associated* with an increased risk of fatal and non-fatal CVD. Causative language: Acceptable.
Chen et al[39]	Aim: To review systematically studies examining the association between sedentary lifestyle and low back pain (LBP) using a comprehensive definition of sedentary behaviour including prolonged sitting both at work and during leisure time. Main results: The present review confirms that sedentary lifestyle by itself is not associated with LBP. Causative language: Acceptable.
IJmker et al[41]	Aim: This systematic review summarises the evidence for a relationship between the duration of work time spent using the computer and the incidence of hand–arm and neck–shoulder symptoms and disorders. Main results: Moderate evidence was concluded for a positive *association* between the duration of mouse use and hand–arm symptoms. For this association, indications for a dose–response relationship were found. Causative language: Acceptable.
van Uffelen et al[42]	Aim: To systematically review the evidence on associations between occupational sitting and health risks. Main results: Limited evidence was found to support a positive *relationship* between occupational sitting and health risks. Causative language: Acceptable.
Waersted et al[43]	Aim: This review examines the evidence for an association between computer work and neck and upper extremity disorders (except carpal tunnel syndrome). Main results: There is limited epidemiological evidence for an association between aspects of computer work and some of the clinical diagnoses studied. Causative language: Acceptable.
Teychenne et al.[44]	Aim: The current literature review aims to systematically examine the evidence investigating the association between physical activity, sedentary behavior, and postnatal depressive symptoms, focusing particularly on the dose and domain in which these behaviors are undertaken. Main results: There is limited evidence suggesting that there are positive *associations* between sedentary behavior and postnatal depressive symptoms.

*For reviews that used a causal or qualified causal language in their results, we show whether they included randomized controlled trials were or not.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	NA
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5 and Suppl Fil 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6 and Suppl Fil 2
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6-7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Suppl Fil 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Suppl Fil 4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	11
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Suppl Fil 4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	17
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	21

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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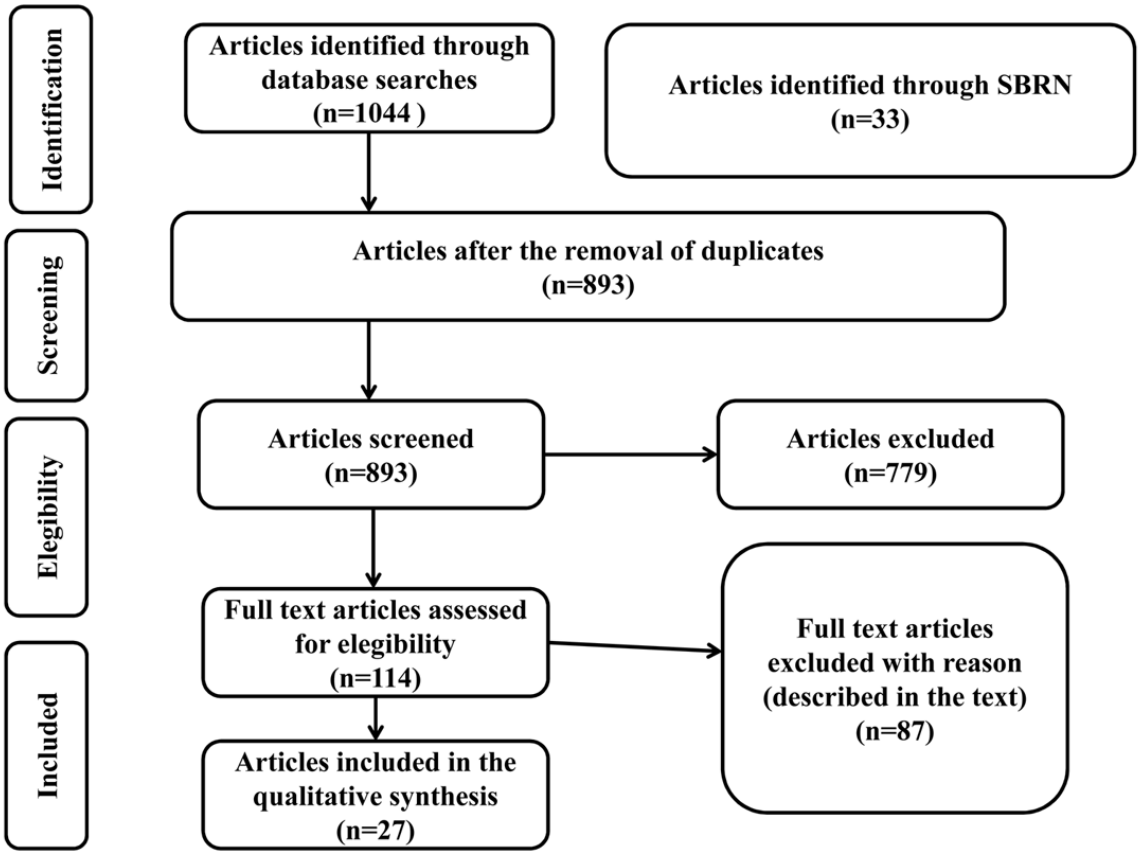
Figure 1 - Flow diagram of the studies included in the overview.



ANEXO C

ARTIGO 3

Effect of Physical Inactivity on Major Non-Communicable Diseases and Life Expectancy in Brazil

Artigo Aceito para Publicação no *Journal of Physical Activity and Health*

CARTA DE ACEITE

Dear Mr. Rezende:

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Journal of Physical Activity & Health

Effect of Physical Inactivity on Major Non-Communicable Diseases and Life Expectancy in Brazil

Running head: **Physical Inactivity in Brazil**

Manuscript type: Original Research

Keywords: motor activity, non-communicable disease, life expectancy

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Abstract

Background: In Brazil, one fifth of the population reports not doing any physical activity. This study aimed to assess the impact of physical inactivity on major non-communicable diseases (NCDs), all-cause mortality and life expectancy in Brazil, by region and socio-demographic profile.

Methods: We estimated the population attributable fraction (PAF) for physical inactivity associated with coronary heart disease, type 2 diabetes, breast cancer, colon cancer and all-cause mortality. To calculate the PAF, we used the physical inactivity prevalence from the 2008 Brazilian Household Survey and relative risk data in the literature.

Results: In Brazil, physical inactivity is attributable to 3–5% of all major NCDs and 5.31% of all-cause mortality, ranging from 5.82% in the southeastern region to 2.83% in the southern region. Eliminating physical inactivity would increase the life expectancy by an average of 0.31 years. This reduction would affect mainly individuals with ≥ 15 years of schooling, male, Asian, elderly, residing in an urban area and earning ≥ 2 times the national minimum wage.

Conclusions: In Brazil, physical inactivity has a major impact on NCDs and mortality, principally in the southeastern and central-west regions. Public policies and interventions promoting physical activity will significantly improve the health of the population.

Introduction

In recent years, almost two thirds of all deaths worldwide were the result of non-communicable diseases (NCDs),[1] including coronary heart disease, cancer and type 2 diabetes, recognized by the United Nations as the main maladies that threaten public health.[2] In Brazil, these diseases were responsible for 72% of all deaths in 2007 and are the leading causes of disease burden (affecting 59.5 million people).[3]

In Brazil, the *Sistema Único de Saúde* (SUS, Unified Health Care System) provides comprehensive, universal care for the prevention and treatment of disease. The SUS covers approximately 143.6 million of people, corresponding to approximately 80% of the Brazilian population. The country has progressively improved access to patient care, facilitating the prevention and management of NCDs.[4] In 2012, there were 468,000 hospitalizations for the major NCDs (coronary heart disease, diabetes, colon cancer and breast cancer), at a cost of approximately US$524 million.[5]

According to the World Health Organization (WHO),[6] the estimated number of disability-adjusted life years lost to NCDs in the 2006-2015 period in Brazil will result in a total financial loss of approximately US$4 billion. The major NCDs (coronary heart disease, diabetes, colon cancer and breast cancer) have four risk factors in common—smoking, an unhealthy diet, physical inactivity and alcohol abuse—and those factors have been a focus of public health polices in Brazil.[7] Expanding our knowledge of the impact of physical inactivity on NCD-related morbidity is an important step toward improving health care policies in Brazil, especially those related to cost reduction and primary prevention.

There is strong scientific evidence that physical inactivity is associated with the development of coronary heart disease,[8] type 2 diabetes[9] and cancer, particularly breast cancer[10] and colon cancer.[11,12] In addition, various studies have indicated that physical activity is a determinant of longevity, in the healthy and the ill alike.[13] In a recent study, Lee et al[14] estimated that physical inactivity is the cause of 6–10% of all major NCDs worldwide and of 8–14% in Brazil. However, it remains unknown how this differs among the regions of Brazil and by socio-demographic profile. With a population of approximately 194 million, Brazil is heterogeneous from a racial, cultural and economic perspective, and great social inequalities persist.

The objective of this study was to determine the impact that physical inactivity has on the morbidity associated with the major NCDs, as well as on all-cause mortality and life expectancy in Brazil, by region and by socio-demographic profile. We also attempted to estimate the effect that eliminating physical inactivity would have on the prevalence of the major NCDs and on the life expectancy of the population.

Methods

Outcome Measures

The main outcome measures of this study were coronary heart disease, type 2 diabetes, breast cancer and colon cancer. These diseases were chosen because of their significant impact on public health, as well as their well-known association with physical inactivity. Because these diseases also are major causes of mortality in Brazil, we also evaluated the impact of physical inactivity on all-cause mortality and life expectancy.

Population Attributable Fraction

We calculated the population attributable fraction (PAF) on the basis of the prevalence of physical inactivity and of the relative risk (RR) of the major associated NCDs and all-cause mortality,[14] using the following equations:

$$PAF = Pd(RR_{adj}-1)/RR_{adj}$$

$$PAF = Pe(RRunadj-1)/\ Pe(RRunadj-1)+1$$

where *Pd* is the proportion of physically inactive individuals among the cases, RR_{adj} is the RR (inactive vs. active individuals)—for the NCDs selected and for all-cause mortality—adjusted for confounding variables, *Pe* is the proportion of physically inactive individuals within the population, and *RRundaj* is the unadjusted RR. In order to provide a conservative estimative, we opted to use the former equation whenever there were confounders of the relationships between physical inactivity and the outcomes evaluated. We performed Monte Carlo simulation (10,000 simulations) to estimate the 95% confidence interval for the PAF, assuming a normal distribution (mean ± SD) of physical inactivity and log of the RRs (Supplementary File 1).

Estimation of the Prevalence of Physical Inactivity

The prevalence of physical inactivity in the population was obtained from the 2008 Brazilian *Pesquisa Nacional por Amostra de Domicílios* (PNAD, National Household Survey).[15] The 2008 PNAD used probability sampling to select participants who are representative of the Brazilian adult population, through multiple stages of selection:

primary (at the city level); secondary (at the census tract level); and tertiary (at the household level). Further details about PNAD sampling are described elsewhere.[15] Physical inactivity among subjects ≥ 14 years of age was evaluated with an eight-question self-report questionnaire that addresses the following domains: physical activity in the commute to work; physical activity at work; and physical activity at home or in leisure activities (Supplementary File 2). An individual was considered physically inactive if reporting not engaging in physical activity in any of the domains studied. The prevalence of physical inactivity in Brazil was stratified by sex, age, race, location, level of education, monthly family income, state and region (Supplementary File 3 and 4).

In order to calculate the PAF, we used an estimate of the prevalence of physical inactivity among individuals with coronary heart disease, type 2 diabetes, breast cancer or colon cancer, using the adjustment factors calculated by Lee et al.[14] The adjustment factors for each of the outcomes were multiplied by the prevalence of physical inactivity provided by the 2008 PNAD.

Estimation of the RR for physical inactivity

In calculating the physical inactivity PAF for each of the outcomes studied, we used the RRs obtained in the systematic search of the literature conducted by Lee et al.[14]

Gains in life expectancy

Potential gains in life expectancy attributed to the elimination of physical inactivity were calculated using the life tables available from the WHO[16] which provide age-specific death rates for the Brazilian population in 2009. The years gained were estimated by

reducing the PAF for physical inactivity in all-cause mortality at 40-79 years of age, by regional and socioeconomic variables. The difference between life expectancies (on the life table and calculated) represents the years that would be gained by eliminating physical inactivity in the population.[17,18]

Absolute Values for Reduction in Non-Communicable Diseases and in All-Cause Mortality

In order to assess the absolute impact represented by the calculated PAF, the number of cases of the NCDs studied and all-cause mortality deaths were extracted from official data compiled by the Brazilian National Ministry of Health.[5,19]

Absolute values for the morbidity associated with coronary heart disease and type 2 diabetes mellitus refer to the number of hospitalizations in the year 2008 and were obtained from the SUS Hospital Information Service.[5] The data used represent the absolute number of hospitalizations that would be avoided if physical inactivity were eliminated. The potential numbers of cases of breast, colon and uterine cancer that would be averted were based on the absolute numbers of cases obtained from the *Instituto Nacional do Câncer* (INCA, National Cancer Institute) for 2007.[19]

Absolute number of all-cause mortality were obtained from the Brazilian National Mortality Database.[5] These figures were used in calculating the absolute number of deaths that could be avoided if physical inactivity were eliminated.

Results:

The overall prevalence of physical inactivity in Brazil was estimated to be 19.9%, corresponding to 28.2 million inhabitants. Among the cases of type 2 diabetes, the estimated prevalence of physical inactivity was 24.48%, whereas it was 23.88% among the cases of coronary heart disease, 20.89% among those of breast cancer, 24.28% among those of colon cancer, and 24.28% among the cases that evolved to death (Table 1). In relation to the outcomes studied, Table 1 also shows the RR reported in Lee et al[14] and the PAF calculated in the present study. Among the outcome measures evaluated, the greatest reduction resulting from the elimination of physical inactivity would be in the incidence of colon cancer, followed by breast cancer, all-cause mortality, type 2 diabetes and coronary heart disease (Table 1).

For coronary heart disease, the PAF for physical inactivity ranged from 3.61% in the southeastern region to 2.83% in the southern region, being 3.29% for Brazil as a whole (Table 2). In 2008, there were 195,045 hospitalizations for coronary heart disease, 6,417 of which could have been avoided if the affected individuals had been physically active.

In relation to type 2 diabetes, the PAF for physical inactivity was estimated to be 4.08% nationwide, ranging from 4.47% in the southeastern region and 3.51% in the southern region (Table 2). In 2008, there were 126,224 hospitalizations for diabetes mellitus, of which 5,150 could have been avoided if people had been physically active.

If physical inactivity had been eliminated in Brazil, 5.18% of all breast cancer cases reported in 2008 could have been avoided. This figure ranged from 5.68% in the southeastern region to 4.46% in the southern region (Table 2). According to INCA estimates for Brazil as a whole, there were 49,400 new cases of breast cancer in 2008.

According to our calculations, 2,559 of those cases could have been avoided if people had engaged in regular physical activity.

In regards to colon cancer, the PAF for physical inactivity was 5.89% nationwide, ranging from 6.45% in the southeastern region to 5.06% in the southern region (Table 2). Proportionally, colon cancer is the disease for which the burden in Brazil would be most reduced by the elimination of physical inactivity. For 2008, the INCA estimated that there were 26,990 new cases, 1,590 of which could have been avoided if the population in the country had engaged in regular physical activity.

For all-cause mortality, the overall (nationwide) PAF for physical inactivity was 5.31%, ranging from 5.82% in the southeastern region to 5.46% in the southern region (Table 2). Of the 1,010,798 deaths in Brazil in 2008, 53,673 were attributed to physical inactivity. As can be seen in Table 2, the potential gain in life expectancy resulting from the hypothetical elimination of physical inactivity in Brazil in 2008 was 0.31 years (ranging from 0.26 in the southern region to 0.34 in the southeastern region).

Brazil is divided into five regions: northern, northeastern, central-west, southeastern, and southern. More than half of the population resides in the southern or southeastern regions, the two regions collectively accounting for more than half of the national gross domestic product. In contrast, the poorest and second poorest regions are the northeastern and northern regions, respectively. The northern and central-west regions have the lowest population density.[4] Additional details are available in the Lancet Series "Health in Brazil". The areas of Brazil that could have benefitted most from the elimination of physical activity, in terms of the outcome measures studied (Table 2), are the southeastern region (particularly the states of São Paulo and Rio de Janeiro) and the

Federal District (located in the central-west region), which are, coincidentally, the areas with the highest levels of economic development.

If physical inactivity were to be eliminated in Brazil, the socio-demographic profile of the individuals in whom the incidence of coronary heart disease, type 2 diabetes, breast cancer and colon cancer, as well as all-cause mortality, would be most significantly reduced is as follows (Table 3): adult male; Asian; over 60 years of age; ≥ 15 years of schooling; residing in an urban area; and earning at least 2 times the national minimum wage.

Discussion

This paper presents the first data estimating the public health impact of physical inactivity on the major NCDs (coronary heart disease, type 2 diabetes, breast cancer and colon cancer) and all-cause mortality in Brazil, by region and by sociodemographic characteristics. We estimated that 3–5% of all cases of major NCDs are attributable to physical inactivity. In addition, 5.31% of the deaths occurring in 2008, corresponding to 53,673 deaths, were attributed to physical inactivity. If physical inactivity were eliminated, the life expectancy of Brazilians would increase by 0.34 years. The increase in life expectancy estimated here is for the Brazilian population as a whole, including both inactive and active individuals, which is relevant to public health. If we had based our calculations solely on inactive individuals who became active, the gains would have been even greater.

Our results show that physical inactivity is one of the main behavioral risk factors for NCDs in Brazil. According to WHO data, physical inactivity was responsible for 6%

of all deaths from NCDs in 2009, corresponding to approximately 3.2 million deaths in the world, putting it behind smoking (13%) but ahead of overweight (5%) as a risk factor for death from an NCD.[20] In a study conducted in the south of Brazil, the risk of stroke was found to he higher among individuals who were physically inactive than among those who were smokers or abused alcohol.[21]

In a study of international scope, Lee et al[14] found that, if physical inactivity were eliminated, life expectancy would increase by 0.68 years worldwide and by 1.08 years in Brazil alone. The gain in life expectancy in Brazil was one of the highest among the countries studied, underscoring the gravity of this problem in the country. However, the PAF values found in the present study were lower than those found for Brazil by Lee et al.[14] There are several possible explanations for this difference. Although both studies used data for 2008, the lower prevalence of physical inactivity in our data translated to lower PAF values. Factors that might have contributed to this discrepancy include an age difference between the populations considered, as well as differences between the two studies in terms of the criteria adopted for classifying physical inactivity. Our study addressed the population over 14 years of age, and subjects were considered sedentary if they reported not engaging in any physical activity within any of the domains studied (commute, work, home and leisure), as assessed by a questionnaire (PNAD). Therefore, we believe that our sample was more representative of the Brazilian population than was that evaluated by Lee et al,[14] who considered only adults (individuals $\geq$ 18 years of age) and classified as sedentary subjects who did not engage in physical activity for 150 min weekly, as recommended by the WHO.[22] In the aforementioned study,[14] there was a

considerable number of individuals who were active for only slightly less than 150 min/week and were considered physically inactive, which increased the PAF value.

There is mounting evidence that even a minimal amount of physical activity has health benefits. In a prospective cohort study involving over 400,000 subjects in Taiwan, Wen et al[13] showed that, among individuals engaging in physical activity for as little as 15 min per day, all-cause mortality was reduced by 14%. In addition, among such individuals, life expectancy was three years longer than it was among those in the physically inactive group. In a large pooled cohort analysis of six prospective studies,[23] collectively comprising 654,827 adults, a low level of leisure-time physical inactivity (0.1–3.74 metabolic equivalent task-hours/week) was found to be associated with a lower mortality risk (hazard ratio = 0.81; 95% CI: 0.79–0.83) and 1.8 (95% CI: 1.6–2.0) and longer life expectancy. Therefore, we believe that the criteria for classifying physical inactivity used in our study considerably reduced the chance of a bias due to non-differential misclassification, as well as including in the inactive group only people who did not engage in any physical activity in any of the studied domains.

Among the regions of Brazil, the southeast presented the highest PAF related to the incidence of the four NCDs assessed, as well as to all-cause mortality. This is due to the higher mean age and higher prevalence of physical inactivity in the region,[15] particularly during leisure time, despite the high socioeconomic and educational status.[24]

We found that PAF values were higher for males. Although studies have shown that Brazilian men are more active in leisure, work and commuting, domestic chores significantly increase the level of physical activity for Brazilian women.[25] Higher PAF

values were also found for older individuals with a lower level of education, who have been shown to have a lower level of physical activity.[26,27]

When the NCD risk of a population is addressed, it should be borne in mind that underlying behavioral risk factors such as physical inactivity are social determinants, including social inequalities; differences in access to goods and services; low levels of education; and differences in access to information. In this respect, the level of heterogeneity and inequality in Brazil should be considered from various perspectives, taking into consideration cultural, demographic, social and geographic features, which result in different patterns of physical activity and, consequently, different PAF values for NCDs.

The present study has certain limitations. The fact that the physical activity values were self-reported might have been a source of bias. In addition, because the prevalence of physical inactivity among cases is needed in order to arrive at a valid estimate of the PAF adjusted for confounders, we used the adjustment factors devised by Lee et al,[14] which are based mainly on the results of studies conducted in the United States or Europe. Furthermore, the adjustment factor was based on different criteria to define physical inactivity, because the questionnaire used in the present study was different from that employed by Lee et al.[14] However, we believe this to be an improvement over using the unadjusted PAF. According to the RRs, because of the unavailability of data from meta-analyses that address dose-response relationships and differing RRs by gender, age, etc., we were unable to consider such relationships in our analysis. Nevertheless, the use of a two-level categorization (inactivity versus activity) would lead to estimates that are more conservative than are those obtained through the use of a

dose-response categorization. Moreover, people who reported being physical incapable of engaging in activities such as shopping for groceries, medication and clothes were not questioned about their level of physical activity. Therefore, the number of inactive people might have been underestimated.

In an attempt to meet the challenge of NCDs, the Brazilian National Ministry of Health has been implementing major interventions. To address the issue of physical activity, in 2011 the *Academia da Saúde* (Gymnasium of Health) program was developed under the auspices of the SUS.[26] The program has the goal of promoting physical activity in the Brazilian population as a whole and is projected to be implemented in 4,000 municipalities by 2015. In addition, initiatives at the state level, such as the "*Agita São Paulo*" ("Get Moving São Paulo") program, organized by the São Paulo State Department of Health, which has achieved significant results in reducing physical inactivity[28], should be promoted in other states.

Annual surveys have shown that the prevalence of physical inactivity in Brazil has decreased significantly in recent years.[27] However, as the results of the present study indicate, physical inactivity remains responsible for a significant proportion of NCD cases and all-cause mortality in Brazil. Much remains to be done in the areas of public health, transport, socioeconomic development, education, sport and leisure, as well as in other areas, in order to promote healthier lifestyles for the Brazilian population.

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Competing interests: None.

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Table 1 Estimated Prevalence of Physical Inactivity, Relative Risks and Population Attributable Fractions for Physical Inactivity, in Relation to Major Non-Communicable Diseases and All-Cause Mortality—Brazil, 2008.

	Coronary Heart Disease		Type 2 Diabetes		Breast Cancer		Colon Cancer		All-Cause Mortality	
Variable	Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI
Prevalence of Physical Inactivity (%)	23.88	(17.62–32.37)	24.48	(16.45–36.41)	20.89	(11.60–37.63)	24.28	(15.02–39.25)	24.28	(21.45–27.48)
Unadjusted RR	1.33	(1.18-1.49)	1.63	(1.27-2.11)	1.34	(1.25-1.43)	1.38	(1.31-1.45)	1.47	(1.38-1.57)
Adjusted RR	1.49	(1.04–1.30)	1.20	(1.1–1.33)	1.33	(1.26–1.42)	1.32	(1.23–1.39)	1.28	(1.21–1.36)
PAF with Unadjusted RR (%)	6.16	(3.95–8.51)	11.14	(5.91–16.96)	6.34	(5.04–7.67)	7.03	(6.03–8.07)	8.55	(7.26–9.89)
PAF with Adjusted RR (%)	3.29	(1.21–5.44)	4.08	(2.06–6.34)	5.18	(2.44–8.09)	5.89	(3.31–8.64)	5.31	(4.25–6.36)

Abbreviations: CI, confidence interval; RR, relative risk; PAF, population attributable fraction.
Note. Prevalence of physical inactivity in cases in Brazil (2008), for details of the calculation, see Supplementary File 1; RR data taken from Lee et al.[14]

Table 2 Adjusted Population Attributable Fractions for Physical Inactivity, in Relation to Major Non-Communicable Diseases, All-Cause Mortality and Life Expectancy, by Region and State—Brazil, 2008.

Region	CHD		Type 2 Diabetes		Breast Cancer		Colon Cancer		All-Cause Mortality		Life Expectancy (Potential Increase)	
State	PAF	95% CI	PAF	95% CI	PAF	95% CI	PAF	95% CI	PAF	95% CI	Years	95% CI
All of Brazil	**3.29**	**(1.21–5.44)**	**4.08**	**(2.06–6.34)**	**5.18**	**(2.44–8.09)**	**5.89**	**(3.31–8.64)**	**5.31**	**(4.25–6.36)**	**0.31**	**(0.25–0.38)**
North	**3**	**(1.11–4.95)**	**3.71**	**(1.83–5.82)**	**4.72**	**(2.15–7.34)**	**5.35**	**(3.00–7.86)**	**4.83**	**(3.83–5.87)**	**0.29**	**(0.23–0.35)**
Rondônia	2.66	(0.94–4.39)	3.3	(1.60–5.15)	4.19	(1.96–6.55)	4.76	(2.66–7.04)	4.3	(3.37–5.24)	0.25	(0.20–0.31)
Acre	3.31	(1.21–5.61)	4.1	(2.01–6.46)	5.21	(2.31–8.21)	5.92	(3.26–8.76)	5.34	(4.04–6.66)	0.32	(0.24–0.39)
Amazonas	3.43	(1.23–5.71)	4.24	(2.08–6.74)	5.39	(2.48–8.55)	6.12	(3.32–9.05)	5.52	(4.21–6.92)	0.33	(0.25–0.41)
Roraima	3.29	(1.19–5.51)	4.08	(2.00–6.39)	5.18	(2.36–8.11)	5.89	(3.27–8.75)	5.31	(4.10–6.60)	0.31	(0.24–0.39)
Pará	3	(1.11–4.94)	3.71	(1.83–5.83)	4.72	(2.17–7.39)	5.35	(2.98–7.87)	4.83	(3.81–5.86)	0.29	(0.22–0.35)
Amapá	2.43	(0.86–4.13)	3.01	(1.44–4.83)	3.83	(1.68–6.11)	4.35	(2.30–6.46)	3.92	(2.92–5.01)	0.23	(0.17–0.30)
Tocantins	2.4	(0.87–4.01)	2.97	(1.44–4.73)	3.78	(1.73–5.93)	4.29	(2.34–6.34)	3.87	(2.95–4.81)	0.23	(0.17–0.28)
Northeast	**3.13**	**(1.17–5.17)**	**3.87**	**(1.97–6.07)**	**4.92**	**(2.28–7.72)**	**5.59**	**(3.13–8.20)**	**5.04**	**(4.01–6.09)**	**0.30**	**(0.24–0.36)**
Maranhão	3.26	(1.21–5.52)	4.04	(1.95–6.32)	5.13	(2.39–8.09)	5.83	(3.11–8.59)	5.26	(4.01–6.54)	0.31	(0.24–0.39)
Piauí	2.22	(0.79–3.72)	2.75	(1.32–4.35)	3.49	(1.58–5.45)	3.96	(2.17–5.82)	3.58	(2.75–4.41)	0.21	(0.16–0.26)
Ceará	3.05	(1.09–5.01)	3.77	(1.89–5.96)	4.79	(2.22–7.46)	5.44	(3.09–7.97)	4.91	(3.88–5.98)	0.29	(0.23–0.35)
Rio Grande do Norte	3.16	(1.15–5.24)	3.92	(1.95–6.14)	4.98	(2.25–7.85)	5.65	(3.15–8.33)	5.1	(4.03–6.21)	0.30	(0.24–0.37)
Paraíba	3.13	(1.15–5.24)	3.87	(1.96–6.09)	4.92	(2.23–7.76)	5.59	(3.09–8.19)	5.04	(3.97–6.18)	0.30	(0.23–0.37)
Pernambuco	3.24	(1.19–5.41)	4.02	(1.99–6.29)	5.11	(2.31–8.00)	5.8	(3.26–8.53)	5.23	(4.13–6.33)	0.31	(0.24–0.37)
Alagoas	3.66	(1.35–6.17)	4.53	(2.26–7.14)	5.76	(2.62–9.07)	6.54	(3.53–9.76)	5.9	(4.52–7.37)	0.35	(0.27–0.44)
Sergipe	3.64	(1.29–4.51)	4.51	(2.22–7.16)	5.73	(2.59–9.02)	6.51	(3.54–9.67)	5.87	(4.45–7.37)	0.35	(0.26–0.44)
Bahia	3.06	(1.14–5.06)	3.79	(1.92–5.88)	4.82	(2.23–7.49)	5.47	(3.04–8.02)	4.94	(3.91–6.01)	0.29	(0.23–0.36)
Southeast	**3.61**	**(1.29–5.96)**	**4.47**	**(2.25–6.97)**	**5.68**	**(2.74–8.86)**	**6.45**	**(3.64–9.40)**	**5.82**	**(4.65–7.03)**	**0.34**	**(0.27–0.42)**
Minas Gerais	2.9	(1.11–4.79)	3.59	(1.78–5.56)	4.56	(2.12–7.07)	5.18	(2.93–7.58)	4.67	(3.72–5.64)	0.28	(0.22–0.33)
Espírito Santo	3.33	(1.24–5.54)	4.12	(2.06–6.51)	5.24	(2.44–8.24)	5.94	(3.31–8.76)	5.36	(4.25–6.55)	0.32	(0.25–0.39)
Rio de Janeiro	3.94	(1.46–6.56)	4.88	(2.45–7.54)	6.2	(2.92–9.67)	7.04	(3.97–10.35)	6.35	(5.05–7.70)	0.38	(0.30–0.46)
São Paulo	3.84	(1.43–6.40)	4.76	(2.42–7.44)	6.04	(2.83–9.41)	6.86	(3.95–10.07)	6.19	(4.95–7.48)	0.37	(0.29–0.44)
South	**2.83**	**(1.01–4.68)**	**3.51**	**(1.77–5.56)**	**4.46**	**(2.07–6.94)**	**5.06**	**(2.84–7.35)**	**4.56**	**(3.62–5.52)**	**0.27**	**(0.21–0.33)**
Paraná	2.75	(1.01–4.57)	3.4	(1.70–5.26)	4.32	(1.98–6.68)	4.91	(2.78–7.21)	4.43	(3.48–5.41)	0.26	(0.21–0.32)
Santa Catarina	2.83	(1.05–4.74)	3.51	(1.71–5.50)	4.46	(2.06–7.02)	5.06	(2.81–7.47)	4.56	(3.55–5.65)	0.27	(0.21–0.33)
Rio Grande do Sul	2.91	(1.09–4.82)	3.61	(1.78–5.63)	4.59	(2.20–7.13)	5.21	(2.92–7.57)	4.7	(3.74–5.68)	0.28	(0.22–0.34)
Central-West	**3.26**	**(1.19–4.04)**	**4.04**	**(2.00–6.27)**	**5.13**	**(2.39–7.98)**	**5.83**	**(3.28–8.52)**	**5.26**	**(4.20–6.36)**	**0.31**	**(0.25–0.38)**
Mato Grosso	2.62	(0.94–4.35)	3.24	(1.61–5.07)	4.12	(1.88–6.49)	4.67	(2.55–6.89)	4.22	(3.30–5.14)	0.25	(0.19–0.30)
Mato Grosso do Sul	3.19	(1.18–5.29)	3.96	(1.94–6.19)	5.03	(2.34–7.84)	5.71	(3.18–8.37)	5.15	(4.03–6.29)	0.30	(0.24–0.37)
Goiás	3.28	(1.20–5.41)	4.06	(2.01–6.34)	5.16	(2.44–8.05)	5.86	(3.26–8.62)	5.28	(4.17–6.42)	0.31	(0.25–0.38)
Federal District of Brasília	3.91	(1.34–6.52)	4.84	(2.43–7.62)	6.15	(2.81–9.40)	6.98	(3.85–10.28)	6.3	(5.00–7.66)	0.37	(0.30–0.45)

Abbreviations: CHD, coronary heart disease; PAF, population attributable fraction; CI, confidence interval.

Table 3 Adjusted Population Attributable Fractions for Physical Inactivity, in Relation to Major Non-Communicable Diseases, All-Cause Mortality and Life Expectancy, by Socio-Demographic Variables—Brazil, 2008.

	CHD		Type 2 Diabetes		Breast Cancer		Colon Cancer		All-Cause Mortality		Life Expectancy (Potential Increase)	
Variable	PAF	95% CI	PAF	95% CI	PAF	95% CI	PAF	95% CI	PAF	95% CI	Years	95% CI
Sex												
Male	4.17	(1.50–6.85)	5.17	(2.55–8.05)	–	–	7.45	(4.14-10.90)	6.73	(5.32–8.11)	0.39	(0.31–0.48)
Female	2.47	(0.88–4.08)	3.05	(1.51–4.70)	3.88	(1.82–5.99)	4.41	(2.49–6.46)	3.98	(3.19–4.79)	0.23	(0.18–0.28)
Age (years)												
14–29	3.06	(1.10–5.10)	3.79	(1.91–5.88)	4.82	(2.20–7.48)	5.47	(3.08–8.01)	4.94	(3.94 – 5.93)		
30–44	2.71	(0.99–4.49)	3.36	(1.69–5.25)	4.27	(1.99–6.67)	4.85	(2.74 – 7.08)	4.38	(3.51–5.28)		
45–59	3.1	(1.13–5.08)	3.83	(1.92–5.96)	4.87	(2.30–7.56)	5.53	(3.12–8.10)	4.99	(3.99–6.04)		
? 60	5.53	(2.01–9.24)	6.85	(3.52–10.77)	8.7	(4.08–13.67)	9.88	(5.60–14.47)	8.91	(7.11–10.75)		
Years of Schooling												
< 1	3.96	(1.44–6.61)	4.9	(2.47–7.61)	6.23	(2.93–9.75)	7.07	(4.01–10.35)	6.38	(5.06–7.71)	0.38	(0.30–0.46)
1–4	3.08	(1.15–5.07)	3.81	(1.92–5.93)	4.85	(2.29–7.59)	5.5	(3.07–8.02)	4.96	(3.93–5.98)	0.29	(0.23–0.35)
4–7	2.88	(1.06–4.80)	3.57	(1.79–5.55)	4.53	(2.04–7.06)	5.15	(2.91–7.55)	4.64	(3.70–5.59)	0.27	(0.22–0.33)
8–10	2.9	(1.09–4.83)	3.59	(1.75–5.64)	4.56	(2.14–7.09)	5.18	(2.94–7.57)	4.67	(3.75–5.63)	0.28	(0.22–0.33)
11–14	3.44	(1.22–5.68)	4.26	(2.12–6.56)	5.42	(2.55–8.39)	6.15	(3.47–8.95)	5.55	(4.44–6.67)	0.33	(0.26–0.40)
? 15	4.57	(1.73–7.60)	5.66	(2.83–8.84)	7.19	(3.37–11.18)	8.16	(4.62–11.97)	7.37	(5.84–8.86)	0.44	(0.35–0.53)
None declared	1.99	(0.70–3.39)	2.46	(1.14–3.94)	3.13	(1.32–4.97)	3.55	(1.81–5.36)	3.2	(2.33–4.15)	0.19	(0.14–0.24)
Race												
White	3.62	(1.32–6.01)	4.49	(2.25–7.00)	5.71	(2.70–8.83)	6.48	(3.68–9.40)	5.84	(4.69–7.07)	0.35	(0.28–0.42)
Black	3	(1.10–4.96)	3.71	(1.88–5.79)	4.72	(2.21–7.41)	5.35	(3.04–7.83)	4.83	(3.82–5.85)	0.29	(0.23–0.35)
Asian	4.25	(1.43–7.13)	5.27	(2.58–8.23)	6.7	(3.06–10.57)	7.6	(4.21–11.32)	6.86	(5.32–8.46)	0.41	(0.31–0.50)
Mulatto	2.95	(1.08–4.89)	3.65	(1.83–5.70)	4.64	(2.16–7.26)	5.26	(3.01–7.75)	4.75	(3.79–5.71)	0.28	(0.22–0.34)
Indigenous	2.35	(0.83–3.92)	2.91	(1.38–4.63)	3.7	(1.60–5.87)	4.2	(2.30–6.23)	3.79	(2.84–4.78)	0.22	(0.17–0.28)
Location												
Rural	2.28	(0.84–3.78)	2.83	(1.41–4.39)	3.6	(1.71–5.63)	4.08	(2.28–5.97)	3.68	(2.91–4.46)	0.22	(0.17–0.26)
Urban	3.48	(1.27–5.74)	4.31	(2.16–6.70)	5.47	(2.56–8.51)	6.21	(3.53–9.05)	5.6	(4.47–6.77)	0.33	(0.26–0.40)
Monthly Income												
0–0.74× MW	2.75	(1.05–4.53)	3.4	(1.70–5.29)	4.32	(2.04–6.75)	4.91	(2.80–7.21)	4.43	(3.53-5.34)	0.26	(0.21–0.32)
0.75–1.99× MW	3.24	(1.19–5.38)	4.02	(1.98–6.25)	5.11	(2.42–7.97)	5.8	(3.25–8.45)	5.23	(4.14-6.30)	0.31	(0.24–0.37)
? 2× MW	4.32	(1.61–7.10)	5.35	(2.70–8.36)	6.8	(3.22–10.59)	7.72	(4.36–11.23)	6.97	(5.57-8.38)	0.41	(0.33–0.50)
None declared	4.35	(1.55–7.26)	5.39	(2.72–8.49)	6.85	(3.25–10.69)	7.78	(4.42–11.41)	7.02	(5.60-8.48)	0.42	(0.33–0.50)

Abbreviations: CHD, coronary heart disease; PAF, population attributable fraction; CI, confidence interval; MW, (national) minimum wage.

Note. The national monthly minimum wage in 2008, in Brazilian reals (R$), was R$ 415.00, equal to approximately US$207.50; the current national monthly minimum wage is R$678.00, equal to approximately US$339.00 (by coincidence, the current exchange rate is approximately 2:1, as it was in 2008).

SUPPLEMENTARY FILE 1

For each exposure:

Adjustment factor
- Given data:
  1. AF : adjustment factor
  2. $var(ln\,\mathrm{AF})$: variance of $ln\,\mathrm{AF}$

- Calculate:
  1. $ln\,\mathrm{AF}$

Relative risk
Unadjusted

- Given data:
  1. $\mathrm{RR_{unadj}}$: unadjusted relative risk
  2. $95\%\ \mathrm{CI}(\mathrm{RR_{unadj}}) = (\mathrm{RR_{unadj}^{lower}} - \mathrm{RR_{unadj}^{upper}})$: $\mathrm{RR_{unadj}}$ 95% confidence interval
  3. $\mathrm{RR_{unadj}^{lower}}$: lower limit of $\mathrm{RR_{unadj}}$ 95% confidence interval
  4. $\mathrm{RR_{unadj}^{upper}}$: upper limit of $\mathrm{RR_{unadj}}$ 95% confidence interval

- Calculate:
  1. $ln\,\mathrm{RR_{unadj}}$
  2. $var(ln\,\mathrm{RR_{unadj}}) = \left(\frac{ln\,\mathrm{RR_{unadj}^{upper}} - ln\ \mathrm{RR_{unadj}^{lower}}}{(1{,}96)^2}\right)^2$: variance of $ln\,\mathrm{RR_{unadj}}$

Adjusted
- Given data:
  1. $\mathrm{RR_{adj}}$: adjusted relative risk
  2. $95\%\ \mathrm{CI}(\mathrm{RR_{adj}}) = (\mathrm{RR_{adj}^{lower}} - \mathrm{RR_{adj}^{upper}})$: $\mathrm{RR_{adj}}$ 95% confidence interval
  3. $\mathrm{RR_{adj}^{lower}}$: lower limit of $\mathrm{RR_{adj}}$ 95% confidence interval
  4. $\mathrm{RR_{adj}^{upper}}$: upper limit of $\mathrm{RR_{adj}}$ 95% confidence interval

- Calculate:
  1. $ln\,\mathrm{RR_{adj}}$
  2. $var(ln\,\mathrm{RR_{adj}}) = \left(\frac{ln\,\mathrm{RR_{adj}^{upper}} - ln\ \mathrm{RR_{adj}^{lower}}}{(1{,}96)^2}\right)^2$: variance of $ln\,\mathrm{RR_{adj}}$

Prevalence:
Proportion of inactive people in the source population

- Given data:
  1. $\mathrm{P_e}$: proportion of inactive people in the source population
  2. $95\%\mathrm{CI}(\mathrm{P_e}) = (\mathrm{P_e^{lower}} - \mathrm{P_e^{upper}})$: $\mathrm{P_e}$ 95% confidence interval

3. $\mathrm{P_e^{lower}}$: lower limit of $\mathrm{P_e}$ 95% confidence interval
4. $\mathrm{P_e^{upper}}$: upper limit of $\mathrm{P_e}$ 95% confidence interval

- Calculate:

1. $var(\mathrm{P_e}) = \left(\frac{\mathrm{P_e^{upper}} - \mathrm{P_e^{lower}}}{(1{,}96)^2}\right)^2$: variance of $\mathrm{P_e}$
2. $ln\,\mathrm{P_e}$
3. $var(ln\,\mathrm{P_e}) = \left(\frac{ln\,\mathrm{P_e^{upper}} - ln\,\mathrm{P_e^{lower}}}{(1{,}96)^2}\right)^2$: variance of $ln\,\mathrm{P_e}$

Proportion of inactive people among cases

- Calculate:

1. $ln\,\mathrm{P_d} = ln\,\mathrm{P_e} + ln\,\mathrm{AF}$
2. $P_d = \exp\{ln\,\mathrm{P_d}\}$: proportion of inactive people among cases
3. $var(ln\,\mathrm{P_d}) = var(ln\,\mathrm{P_e}) + var(ln\,\mathrm{AF})$: variance of $ln\,\mathrm{P_d}$
4. $se(ln\,\mathrm{P_d}) = \sqrt{var(ln\,\mathrm{P_d})}$: standard error of $ln\,\mathrm{P_d}$
5. $\mathrm{EF} = \exp\{1.96 \cdot se(ln\,\mathrm{P_d})\}$: error factor of $\mathrm{P_d}$
6. $\mathrm{P_d^{lower}} = \mathrm{P_d}/\mathrm{EF}$: lower limit of $\mathrm{P_d}$ 95% confidence interval
7. $\mathrm{P_d^{upper}} = \mathrm{P_d} \cdot \mathrm{EF}$: upper limit of $\mathrm{P_d}$ 95% confidence interval
8. $var(\mathrm{P_d}) = \left(\frac{\mathrm{P_d^{upper}} - \mathrm{P_d^{lower}}}{(1{,}96)^2}\right)^2$: variance of $\mathrm{P_d}$

Monte Carlo simulation

Repeat 10,000 times:

1. $p_e \sim N\left(\mathrm{P_e}, var(\mathrm{P_e})\right)$: choose a random value for $\mathrm{P_e}$ using a Normal distribution
2. $ln\,rr_{unadj} \sim N\left(ln\,\mathrm{RR_{unadj}}, var\left(ln\,\mathrm{RR_{unadj}}\right)\right)$: choose a random value for $ln\,\mathrm{RR_{unadj}}$ using a Normal distribution
3. $rr_{unadj} = \exp\{ln\,rr_{unadj}\}$
4. $paf_1 = \frac{p_e \cdot (rr_{unadj} - 1)}{p_e \cdot (rr_{unadj} - 1) + 1}$: population attributable fraction, using unadjusted relative risk
5. $p_d \sim N\left(\mathrm{P_d}, var(\mathrm{P_d})\right)$: choose a random value for $\mathrm{P_d}$ using a Normal distribution
6. $ln\,rr_{adj} \sim N\left(ln\,\mathrm{RR_{adj}}, var\left(ln\,\mathrm{RR_{adj}}\right)\right)$: choose a random value for $ln\,\mathrm{RR_{adj}}$ using a Normal distribution
7. $rr_{adj} = \exp\{ln\,rr_{adj}\}$
8. $paf_2 = \frac{p_d \cdot (rr_{adj} - 1)}{rr_{adj}}$: population attributable fraction, using adjusted relative risk
9. Save the 10,000 calculated values of paf_1 and paf_2

End of simulation.

Population Attributable Fraction

- Calculate:

1. $\mathrm{PAF}_1 = \frac{\mathrm{P_e}\cdot(\mathrm{RR_{unadj}}-1)}{\mathrm{P_e}\cdot(\mathrm{RR_{unadj}}-1)+1}$: population attributable fraction, using $\mathrm{RR_{unadj}}$
2. $\mathrm{PAF}_1^{\mathrm{lower}} = 5^{th}$ percentile of the calculated values of paf_1 : lower limit of PAF_1 95% confidence interval
3. $\mathrm{PAF}_1^{\mathrm{upper}} = 95^{th}$ percentile of the calculated values of paf_1 : upper limit of PAF_1 95% confidence interval

4. $\mathrm{PAF}_2 = \frac{\mathrm{P_d}\cdot(\mathrm{RR_{adj}}-1)}{\mathrm{RR_{adj}}}$: population attributable fraction, using $\mathrm{RR_{adj}}$
5. $\mathrm{PAF}_2^{\mathrm{lower}} = 5^{th}$ percentile of the calculated values of paf_2 : lower limit of PAF_2 95% confidence interval
6. $\mathrm{PAF}_2^{\mathrm{upper}} = 95^{th}$ percentile of the calculated values of paf_2 : upper limit of PAF_2 95% confidence interval

SUPPLEMENTARY FILE 2 – Physical Activity Questionnaire (PNAD 2008)

PA Transport
1. Do you usually walk or bike from home to work?
a) Yes
b) No (if no go directly to question 3)
2. How much time you spend to go to and to get back from work
a) 10 minutes or less
b) 10-19 minutes
c) 20-29 minutes
d) 30-44 minutes
e) 45-59 minutes
f) 60 minutes or more

PA Occupational
3. In your work, you walk most of the time, weight loads or do any other activity that requires physical exertion?
a) Yes
b) No
c) Don't Know

Home PA
4. Who usually does the cleaning (heavy cleaning) in your home?
a)yourself
b) yourself with another
c) other person
Leisure PA

5. In the last three months you have practiced some form of physical exercise or sport?
a) Yes
b) No (if not, finish the questionnaire).

6. What is the main form of exercise or sport you practice?
a) Walking
b) Soccer, basketball, aerobic classes, running or tennis
c) other: _____
d) Don't practice anymore

7. How many days per week do you practice physical exercise or sport?
a) 1-2 days a week
b) 3-4 days a week
c) 5-6 days a week
d) every day

8. The day you practice physical exercise or sport, how long does it take?

a) less than 20 minutes
b) 20-29 minutes
c) 30 minutes or more

SUPPLEMENTARY FILE 3

Prevalence of Physical Inactivity by Sex, Gender, Race, Location, Level of Education and Monthly Family Income—Brazil, 2008.[1]

Variable	Prevalence %	Prevalence 95% CI
Brazil	19.9	(19.6-20.2)
Sex		
Male	25.2	(24.8–25.6)
Female	14.9	(14.6–15.2)
Age (years)		
14–29	18.5	(18.1–18.9)
30–44	16.4	(16.1–16.8)
45–59	18.7	(18.3–19.1)
≥ 60	33.4	(32.7–34.1)
Race		
White	21.9	(21.6–22.3)
Black	18.1	(17.4–18.8)
Asian	25.7	(22.5–29.0)
Mulatto	17.8	(17.4–18.1)
Indigenous	14.2	(11.6–16.7)
Location		
Rural	13.8	(13.0–14.6)
Urban	21.0	(20.7–21.3)
Educational Status (years)		
< 1	23.9	(23.1–24.6)
1–4	18.6	(18.0–19.2)
4–7	17.4	(17.0–17.8)
8–10	17.5	(17.1–17.9)
11–14	20.8	(20.4–21.2)
≥ 15	27.6	(26.8–28.4)
None declared	12.0	(9.3–14.8)
Monthly Family Income		
0–0.74× MW	16.6	(16.1–17.0)
0.75–1.99× MW	19.6	(19.2–19.9)
≥ 2× MW	26.1	(25.5–26.6)
None declared	26.3	(25.0–27.5)

Abbreviations: CI, confidence interval; MW, (national) minimum wage.

Note. The national monthly minimum wage in 2008, in Brazilian reals (R$), was R$ 415.00, equal to approximately US$207.50; the current national monthly minimum wage is R$678.00, equal to approximately US$339.00 (by coincidence, the current exchange rate is approximately 2:1, as it was in 2008).

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SUPPLEMENTARY FILE 4

Prevalence of Physical Inactivity by State and Region - Brazil, 2008.[1]

Region	Prevalence	
State	%	95% CI
Brazil	19.9	(19.6-20.2)
North	18.1	(17.2–19.1)
Rondônia	16.1	(14.6–17.5)
Acre	20.0	(16.9–23.2)
Amazonas	20.7	(17.6–23.9)
Roraima	19.9	(17.3–22.5)
Pará	18.1	(16.8–19.3)
Amapá	14.7	(11.8–17.7)
Tocantins	14.5	(12.4–16.7)
Northeast	18.1	(17.2–19.1)
Maranhão	19.7	(16.8–22.6)
Piauí	13.4	(11.5–15.2)
Ceará	18.4	(17.2–19.6)
Rio Grande do Norte	19.1	(17.4–20.7)
Paraíba	18.9	(16.9–20.9)
Pernambuco	19.6	(18.3–21.0)
Alagoas	22.1	(18.8–25.5)
Sergipe	22.0	(18.3–25.8)
Bahia	18.5	(17.3–19.6)
Southeast	21.8	(21.4–22.2)
Minas Gerais	17.5	(16.9–18.1)
Espírito Santo	20.1	(18.3–21.9)
Rio de Janeiro	23.8	(22.9–24.7)
São Paulo	23.2	(22.5–23.8)
South	17.1	(16.4–17.8)
Paraná	16.6	(15.5–17.8)
Santa Catarina	17.1	(15.0–19.2)
Rio Grande do Sul	17.6	(16.7–18.4)
Central-West	19.7	(18.9–20.5)
Mato Grosso do Sul	15.8	(14.3–17.4)
Mato Grosso	19.3	(17.4–21.1)
Goiás	19.8	(18.5–21.1)
Federal District of Brasília	23.6	(22.1–25.1)

Abbreviations: CI, confidence interval; MW, (national) minimum wage.

Note. The national monthly minimum wage in 2008, in Brazilian reals (R$), was R$ 415.00, equal to approximately US$207.50; the current national monthly minimum wage is R$678.00, equal to approximately US$339.00 (by coincidence, the current exchange rate is approximately 2:1, as it was in 2008).

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APÊNDICE

GLOSSÁRIO - Definições de atividade física e comportamento sedentário

A qualidade das medidas de exposição e desfecho em estudos epidemiológicos são essenciais para garantir a validade dos estudos (Rothman et al., 2008). Nesse sentido, a fim de transmitir uma mensagem fidedigna em trabalhos acadêmicos, faz-se necessário definir e padronizar termos e nomenclaturas.

As definições a seguir são apresentadas para haver melhor entendimento sobre termos específicos encontrados na literatura:

- **Atividade física**: é um comportamento complexo e multidimensional, o qual não deve ser tratado como sinônimo de gasto energético (Lamonte; Ainsworth, 2001; Gabriel et al., 2012). Foi apontado por Caspersen et al. (1985, p. 126) que "o estudo epidemiológico de qualquer conceito ou evento exige que o item sob investigação seja definido e mensurado", e o conceito que predomina até a atualidade com alguns primeiros fundamentos conceituais, paradigmáticos e metodológicos da área da atividade física relacionada à saúde estão muito presentes até hoje (Powell e Paffenbarger, 1985). De acordo com o manuscrito seminal de Caspersen, Powell e Christenson, a atividade física pode ser definida como "qualquer movimento corporal produzido pelos músculos esqueléticos que resulta em gasto de energia" (Caspersen et al., 1985, p. 126). Sem dúvida, a escolha do gasto

energético resultante da intensidade, duração e frequência da movimentação do corpo como *proxy* mensurável fundamental do nível de atividade física tem um viés biológico e epidemiológico, e foi muito influenciado pelos tipos de estudos e resultados obtidos a partir de meados do século XX. A atividade física pode ser avaliada em diferentes dimensões: lazer, transporte, trabalho e doméstica.

- **Exercício físico**: tipo de atividade física, planejada, estruturada e repetitiva com o objetivo de melhorar um ou mais componentes da aptidão física (Caspersen et al., 1985).

- **Unidade metabólica (MET)** expressa a aptidão cardiorrespiratória, em que cada MET equivale aproximadamente ao consumo de 3,5 ml/Kg/min de O_2, equivalente ao gasto energético basal (Ainsworth et al., 2011).

- **Atividade física leve**: atividade que apresenta um equivalente metabólico 1,6 a 2,9 METs.

- **Atividade física moderada a vigorosa:** atividade física com equivalente metabólico igual ou superior a 3 unidades metabólicas (Pate et al., 1995; Haskell et al., 2007).

- **Fisicamente ativo:** Cumprir a recomendação de atividade física de 150 minutos semanais em intensidade moderada a vigorosa. Pode ser realizada em sessões de 30 minutos, em cinco dias da semana, com intensidade moderada, ou 10 minutos, em 3 dias da semana. A combinação de atividade física moderada e vigorosa pode ser realizada para atender a recomendação. A recomendação pode ser realizada de forma contínua

(sessão de 30 minutos) ou acumulada (com blocos de pelo menos 10 minutos) (Pate et al., 1995; Haskell et al., 2007).

- Insuficientemente ativo ou inativo: não praticar atividade física, em proporções de tempo e intensidade pré-estabelecidas pelas recomendações de atividade física (Pate et al., 1995).

- Comportamento sedentário (Sedentarismo): sedentário vem do Latim *sedere*, que significa sentar. São atividades que apresentam um gasto energético próximo ou compatível aos níveis de repouso (1-1,5 METS). Atividades que envolvem posições sentada, inclinada ou deitada, como assistir à televisão, usar o computador, jogar vídeogame, e têm sido utilizadas para medir esse comportamento (Pate et al., 2008).