

Expert Working Group Working Paper

Sedentary Behaviour

UK physical activity guidelines: Draft review and recommendations for Sedentary Behaviour

October 2018

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Background

UK physical activity guidelines

The first UK physical activity guidelines were produced in 1996 following the 1994 Ascot Meeting of UK and international experts, who agreed recommendations for adults (1, 2). These recommendations were then extended to include new recommendations for children and young people in 1998 (3). These recommendations included suggestions about the frequency, intensity and time of aerobic physical activity needed for each age group but also included the first recommendation for muscle strengthening, flexibility and bone health for children and young people only. In 2004 the English Chief Medical Officer formally endorsed these recommendations and thus began a continuing relationship with their production and dissemination that has continued to today. At the same time Scotland and Wales had adopted similar guidelines and following the publication of the 2008 USA physical activity guidelines (4), the UK CMOs harmonised and produced the current physical activity guidelines, published in 2011 (5). These included, for the first time, recommendations for Under 5s and for all age groups, sedentary behaviour (6).

Impact of sedentary behaviour on health

In recent years, there has been increasing awareness of the impact that sedentary behaviour may have on health. Sedentary behaviour is defined as those behaviours performed during waking hours in a sitting, reclining or lying posture with little energy being expended (≤ 1.5 MET). It is not simply the absence of physical activity. It includes behaviours such as watching television, reading, working with a computer, sitting while playing video games, or travelling in a motor vehicle. The most common measures of sedentary time used in the literature are self-reported time spent sitting, watching TV/computer use, and the volume of device-based measures of sedentary time (accelerometer/inclinometer). In addition, the pattern of sedentary time appears to be important, with sitting for prolonged periods associated with adverse health effects, which may be ameliorated by interrupting sedentary time by light activity or walking. Despite the increasing evidence base for the deleterious effect of sedentary behaviour, current guidelines do not provide detailed guidance for modifying sedentary behaviour, stating that people across the age range from 5-65+ years should “.....minimise the amount of time spent being sedentary (sitting) for extended periods” (5) or “.....avoid spending long periods sitting down” (7).

The key aim/objective of this working paper is to present potential recommendations for any changes to the existing 2011 UK CMO Physical Activity Guidelines. This working paper presents the findings of each Expert Working Group (EWG) in relation to their area. The document answers a set of questions about potential changes to current physical activity guidelines, by expert scrutiny of the most up to date scientific reviews, and other national guidelines.

Outline of CMO Process

This work will be conducted in three phases (summarised in Figure 1). Phase One has seen the construction of each EWG, selection of international experts, formal purposive systematic reviews of the existing and new evidence, a website for a national consultation on the current UK CMO Guidelines and their implementation, and production of working group papers. All Chairs and Expert Panel members will complete a statement of their declarations of interest.

In Phase Two, draft working papers were developed (this being one of the six papers). The draft papers were circulated to participants attending two Scientific Consensus Meetings (SCM) in Edinburgh and London, during June and July of 2018, respectively. This document has been revised in two ways: i) to reflect the feedback received from both consensus meetings; ii) in response to the updated evidence base.

Phase Three will include a second national consultation on draft physical activity recommendations, and a final round of review and revision. CMO EWGs will then produce a final technical report for UK CMOs with final recommendations for new physical activity guidelines. If the CMOs sign off the suggested recommendations, then the CMO Guidelines Writing Group supports the production of a final CMO Physical Activity Guidelines Report.

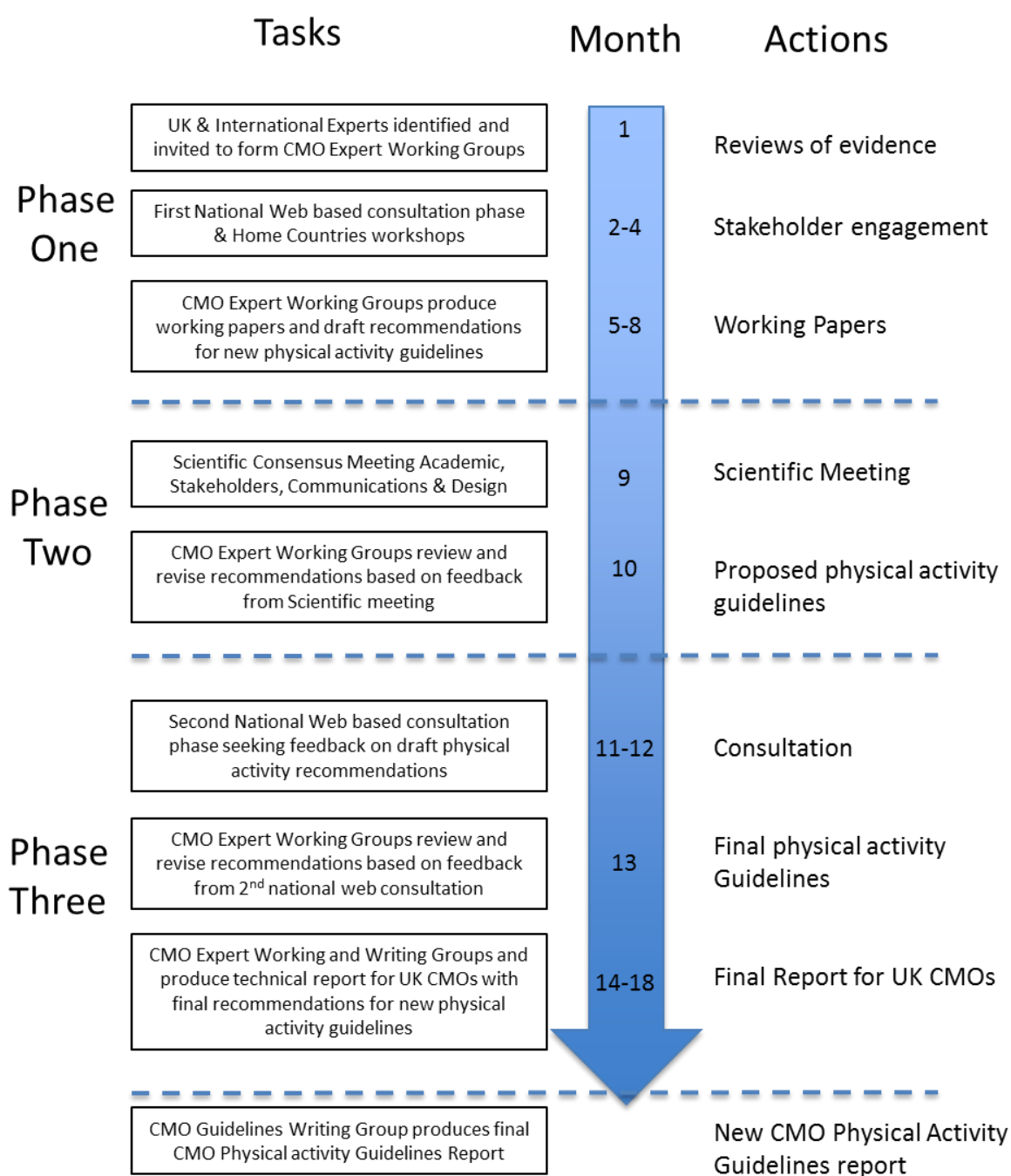


Figure 1 UK Physical activity guidelines review process

Methods for CMO Physical Activity Guidelines Update – EWG Working Papers

Based on the experience of updating guidelines in 2011, as well as resources and time it was deemed impractical to undertake a full review of the primary literature. It was agreed by the EWG Chairs that to identify a set of key review documents to be the primary sources of evidence underpinning the UK review work.

The process to update the 2011 CMO physical activity guidelines drew upon three types of evidence (detailed below): (A) recent published evidence reviews used to construct or update international physical activity guidelines; (B) the most recent pooled analyses, meta-analyses and systematic reviews from prospective and RCT research published since the most recent reviews used to update international guidelines; and (C) any additional relevant papers identified by each EWG. In addition, comments and suggestions about the current 2011 CMO physical activity recommendations were identified for each EWG from the first National Consultation.

Each EWG adopted the same principle, namely, to identify whether there was any new evidence to suggest a change to the existing 2011 guidelines based on the GRADE-ADOPLMENT process (8). Using the GRADE-ADOPLMENT process, the most recent international sedentary behaviour guidelines were identified, these were from the Netherlands. Together with the existing 2011 UK guidelines, this formed the starting point of the review.

The current UK physical activity guidelines were constructed as advice to the general population about the recommended frequency, intensity, time and types of physical activity required to prevent major chronic disease and to maintain health. In the UK, the diseases refer specifically to mortality, years of life lost and disease burden (coronary heart disease, stroke, heart failure, type 2 diabetes mellitus (T2DM), chronic obstructive pulmonary disease (COPD), breast cancer, colorectal cancer, lung cancer, osteoarthritis, dementia and cognitive decline, and depression and depressive symptoms). The guidelines also focus on preventing premature (or all-cause) mortality and fractures, disabilities in the elderly, injuries and, in children, attention deficit hyperactivity disorder (ADHD) symptoms. Four risk factors were also included (systolic blood pressure, LDL cholesterol, body weight (BMI Z-score in children), and insulin sensitivity), which have a causal relationship with these chronic diseases. For the children and young people expert review, muscle strength, cardiorespiratory fitness, bone health, cognitive functioning and academic performance were included as key health indicators for this age group.

The specific steps that were followed to address items A-C that were highlighted above are described in detail below.

A. Identifying recent national evidence reviews used to construct or update physical activity guidelines.

We used Google and targeted public health bodies (i.e. National Centre for Health and Clinical Excellence, Centre for Disease Control) to search for evidence reviews of physical

activity that had been used to construct national physical activity guidelines and recommendations (published since 2010). We also contacted our international experts to identify further examples of relevant reviews from Australia, Canada and The Netherlands. National evidence reviews for the construction of sedentary behaviour guidelines were found for four countries (Australia, Netherlands, New Zealand, USA) in addition to the UK. Evidence statements from the most recent of these (Physical Activity Guidelines Advisory Committee 2018) (9) are summarised below.

Associations of sedentary behaviour with disease outcomes

- Strong evidence demonstrates a significant relationship between greater time spent in sedentary behaviour and higher all-cause and cardiovascular mortality rates. A dose-response relationship is seen, with an increasing slope at higher amounts of sedentary behaviour, although the shape of the relationship differs between all-cause and cardiovascular mortality.
- Strong evidence demonstrates a significant relationship between greater time spent in sedentary behaviour and higher risk of type 2 diabetes, with limited evidence for a direct, graded dose-response relationship.
- Strong evidence demonstrates a significant relationship between greater time spent in sedentary behaviour and higher risk of incident cardiovascular disease, with strong evidence for a direct, graded dose-response relationship.
- Moderate evidence indicates a significant relationship between greater time spent in sedentary behaviour and higher risk of incident endometrial, colon, and lung cancers, with limited evidence for a direct dose-response relationship.
- Limited evidence suggests a direct relationship between greater time spent in sedentary behaviour and higher mortality rates from cancer, and the existence of a direct, positive dose-response relationship between sedentary behaviour and mortality from cancer.
- Limited evidence suggests a positive relationship between greater time spent in sedentary behaviour and higher levels of adiposity and indicators of weight status, with limited evidence for a direct, graded dose-response relationship.

Relationship between sedentary behaviour and MVPA

- Strong evidence demonstrates that the relationship between sedentary behaviour and all-cause mortality varies by amount of moderate-to-vigorous physical activity.
- Moderate evidence indicates that the relationship between sedentary behaviour and mortality from cardiovascular disease varies by amount of moderate-to-vigorous physical activity.
- Insufficient evidence is available to determine whether the relationship between sedentary behaviour and mortality from cancer, risk of Type 2 diabetes, weight status or incident cancer varies by amount of moderate-to-vigorous physical activity.

Bouts or breaks in sedentary time

- Insufficient evidence is available to determine whether bouts or breaks in sedentary behaviour are important factors in the relationship between sedentary behaviour and all-cause mortality, mortality from cardiovascular disease, mortality from cancer, incidence of Type 2 diabetes, weight status, incidence of cardiovascular disease or incident cancer.

Demographic factors

- Overall there is insufficient evidence available to determine whether the relationship between sedentary behaviour and health outcomes (mortality: all-cause, cardiovascular and cancer; Type 2 diabetes; weight status; cardiovascular disease, incident cancer) varies by age, sex, race/ethnicity, socioeconomic status, or weight status.

B. Identifying the most recent pooled analyses, meta-analyses and systematic reviews from prospective and RCT research?

We undertook purposive searches to identify review level relevant literature on the relationship between physical activity, sedentary behaviour and health outcomes. Our searches primarily focused on review level evidence for longitudinal cohort studies examining the relationship between physical activity and health outcomes. We also examined review level evidence for randomised controlled trials in order to identify from systematic review and meta-analyses what types of physical activity were used in effectiveness studies. We searched PubMed using a tailored set of broad MeSH terms (Medical Subject Headings) to capture the most current studies published, relevant to the needs of each EWG. For example, “resistance training”, “muscle”, “bone”, “balance” AND “physical activity” AND “adults”. Full search terms for each EWG are presented in Table 1.

Table 1. Search Terms for Sedentary Behaviour

Mortality	Breast Cancer	Sedentary Behaviour
Morbidity	Lung Cancer	Sitting
Health Outcomes	Prostate Cancer	Screen Time
Coronary Heart Disease	Mental Health	
Cardiovascular Disease	Dementia	Children
Stroke	Cognitive	Young People
Heart Failure	Depression	Adolescents
Diabetes	Quality Of Life	Adults
Chronic Obstructive Pulmonary Disease	Happiness	Older Adults
Osteoarthritis	Sleep	
Sarcopenia	Attention Deficit Hyperactivity Disorder	English
Strength	Blood Pressure	Review
Function	Hypertension	Meta Analysis
Anxiety	Cholesterol	Individual Patient Data
Brain	Obesity	

Behaviour	Insulin Sensitivity	
Academic Performance	Body Weight	
Fractures	Body Composition	
Accidents	Fat Mass	
Falls	Aerobic	
Disability	Resistance	
Injury	Balance	
Cancer	Strength	
Colorectal Cancer	Fitness	
	Muscle	
	Bone	

The terms of the searches and their dates reflected the most recent international evidence reviews searches. For example, the Netherlands searches were truncated at 1 October 2016 so searches include all publications from January 1st 2016 (in case of delayed archiving) to 1st January 2018. EWGs identified the most relevant and up to date high quality reviews from these sources and made summations of the effectiveness of the evidence across their health outcomes.

A total of 35 publications relating to sedentary behaviour were identified via the PubMed search by the central review team. These papers were disseminated to the members of the EWG for evaluation. Twelve papers were considered not to be relevant to the review process. Of the remainder, five focussed on youth (10-14), fourteen were included in the review of adults (15-29) and eleven were included in the review of older adults (17-24, 30-32), with eight papers included in both adults and older adults reviews (17-24).

C. Identifying any additional relevant papers by each EWG.

We also asked each EWG to identify any relevant outcomes and primary papers from their own sources and networks. EWGs identified the most relevant and up to date high quality reviews from these sources and made summations of the effectiveness of the evidence across their health outcomes.

To facilitate this task, EWG members took responsibility for identifying and reviewing papers based upon age group (Children and Young People 5-18yrs (CYP): Biddle; Adults (19-64yrs): Clemen & Pulsford; Older adults (65+yrs): Fenton & Fitzsimons). In addition, experimental studies, exploring the impact of interrupting sedentary time, were reviewed by Chastin & Yates. Findings are presented throughout by these groupings. EWG members firstly conducted a review of each of the papers identified, focussing on whether the data in each paper disagreed with previous guidelines for sedentary behaviour. EWG members then utilised these reviews to address the key questions below. We did not consider that we had sufficient expertise within the group to review screen time/sedentary behaviour in under 5s, therefore this was undertaken by the Under 5s EWG. Using the above approaches, the EWG

identified a further 39 papers for review, in addition to those from the central review team (CYP refs (33-39); Adults refs (40-44); Older Adults refs (25, 40, 45-56); Experimental refs (57-69)).

Key questions

Question 1: Is there any evidence that higher levels of sedentary behaviour put individuals at higher risk of poor health? If possible, please clarify the definition of “sedentary” and provide any indication of the amount (quantity) and specify the health outcomes that are covered by this evidence?

Statement 1: For **young people**, evidence suggests that higher levels of sedentary behaviour are weakly associated with greater adiposity and lower physical fitness. Greater sedentary time, and in particular higher leisure screen time, is associated with greater depression and psychological distress although reverse causality cannot be ruled out. In **adults**, there is good evidence that large volumes of sedentary behaviour can negatively impact health, with an association between sitting and all-cause, CVD and cancer mortality, incident cancer, CVD and type 2 diabetes, and a number of mental health outcomes. Large volumes of sitting also negatively impact on a number of physiological parameters including glycaemic control, lipid metabolism and haemodynamic regulation. Similarly, in **older adults**, the evidence suggests that there is a graded relationship between sedentary time and health, with most research focused on all-cause mortality.

Commentary 1: In all age groups, sedentary behaviour is defined as sitting/reclining during waking hours with low energy expenditure (<1.5 METs). In youth, associations with adiposity and fitness are complex and appear not to be causal, and associations with mental health outcomes may be due to reverse causality. In youth, associations are generally more strongly associated with TV and screen time. In both adults and older adults, the magnitude and strength of associations with health outcomes varies according to the precise exposure measure chosen, the population of study and the health outcome of interest. The majority of studies rely on self-report measures of sedentary behaviour, and employ inconsistent definitions of sedentary time. However, dose-response relationships are consistently seen in individual level or study level pooling of the data, particularly for all-cause and CVD mortality.

Question 2: Is there sufficient evidence to review the positive and negative effects of sleep and screen time/sedentary behaviour among under 5s and other age groups? Based on current evidence what, if any, modifications to current sedentary guidelines should be considered?

Note: Under 5s were not considered by this EWG. Sleep was not reviewed specifically.

Statement 2: Large cross-sectional studies have shown that excessive TV watching and computer use are associated with short sleep duration in **young people**. Short sleep duration has been associated with adiposity in young people, but current evidence is limited. In **adults**, both long and short sleep duration have been associated with increased mortality, but evidence for an association between sedentary time and screen time with

sleep is lacking. There is insufficient evidence to review the health implications of screen time and/or sleep among populations of **older adults**.

Commentary 2: In youth, there is little evidence to suggest modification of current guidelines other than possibly adding a statement concerning replacing sitting with more light or moderate-to-vigorous movement where possible and suggesting screens not be used late in the evening. But the latter recommendation is rather speculative given current evidence. In adults, recent meta-regression analyses have found statistically significant linear associations between longer sleep duration and increased mortality and incident cardiovascular disease and also a linear association between a statistically significant increase in mortality and sleep duration at less than six hours. However the role of physical activity/sedentary time on sleep was not considered. There are limited data exploring the association between screen time/sedentary behaviour and sleep in adults, but data from NHANES using accelerometer measurement of sedentary time and self-report of TV viewing found no difference in sedentary time and screen time across sleep quartiles. There is no evidence in older adults to suggest a modification to current guidelines. There is evidence that links screen time (mainly TV viewing) and poorer dietary behaviours. This could inform a recommendation about eating meals away from the TV and avoiding unhealthy snacking during screen time.

Question 3: Is there sufficient evidence to review the negative health effects of sitting time? Based on current evidence what, if any, modifications to current sedentary guidelines should be considered? Should a time limit or minimum threshold be added?

Statement 3: In **young people**, there is little evidence to suggest modification of current guidelines other than possibly adding a statement that it is recommended that young people reduce excessive sitting time, particularly at screens, and replace it with a variety of activities, including light physical activity, and moderate-to-vigorous physical activity. In **adults** and **older adults**, there is an increasing evidence base of both epidemiological and experimental studies. However, epidemiological evidence published since 2016 does not support any significant changes to existing guidance or that a time limit or minimum threshold be added, and experimental supports previous recommendations that prolonged periods of sitting time should be minimised.

Commentary 3: In youth, although a time limit or threshold cannot be fully supported by current evidence, limiting recreational screen time to less than 2h/d would be pragmatic, and has been recommended elsewhere. In adults, there have been noticeable developments in the epidemiological evidence base, particularly regarding associations between sedentary behaviour and cancer risk (17-21) and survivorship (20, 21). Recent meta-analytical data, from 34 studies including 1,331,468 unique individuals (29), concluded that for adults, total sitting and TV viewing time are associated with greater risk of all-cause and CVD mortality above 6–8 h/day of total sitting and 3–4 h/day of TV viewing,

independent of levels of physical activity. Therefore, the EWG considered whether a recommendation of limiting overall sedentary behaviour to a maximum value could be supported.

There are however, a number of issues to consider with such a recommendation. Firstly, the establishment of prescriptive quantitative guidelines is problematic due to the considerable heterogeneity in the control of important confounders, such as socio economic status. Secondly, associations are predominantly based upon self-report data, which may underestimate true sitting/TV time by a large margin. Thirdly, there are problems with regard to messaging such recommendations since they would need to be generally applicable and we would need to be sure that that was the case. For example, different thresholds may apply to highly active adults, older adults or clinical populations. To date, in older adults, although some longitudinal studies provide evidence of a graded association between sedentary time and all-cause mortality (30, 46), there is insufficient evidence to determine a dose–response relationship, or a threshold for clinically relevant risk. **The EWG thus concluded that the epidemiological evidence cannot support a recommendation for a time limit or minimum threshold of sedentary time.**

There is an increasing interest in the impact of breaking prolonged sitting time with either standing, and/or light-intensity physical activity. Prospective epidemiological evidence for the efficacy of interrupting sedentary behaviour on health outcomes is limited and mixed, and has not been reviewed. There are, however, an increasing number of experimental studies that have investigated this issue, with the majority reporting outcomes related to postprandial glucose and insulin responses. A narrative review including 11 studies reported that breaking prolonged sitting with bouts of light-intensity physical activity reduced postprandial glucose between 10-40% compared to prolonged sitting (57). Postprandial metabolism is a marker of cardiometabolic health (58), with elevated postprandial glucose and insulin levels reflective of underlying insulin resistance and predictive of cardiovascular disease and progression to type 2 diabetes. Therefore, this evidence is supportive of the conclusion that breaking prolonged sitting with light intensity physical activity can acutely improve cardiometabolic health through targeting glucose metabolism. Despite the limited prospective evidence, the EWG **supports a recommendation to interrupt prolonged periods of sedentary behaviour with light intensity physical activity.**

Evidence as to whether replacing or breaking prolonged sitting with standing is a sufficient stimulus to promote improved cardiometabolic health in acute studies is inconsistent, and has not been summarised in reviews. Further, whilst evidence summarised in a Cochrane meta-analysis suggested that displacing sitting with standing, largely through the provision of standing desks, did not lead to consistent improvements in musculoskeletal health (60), a more recent meta-analysis concluded that the provision of sit-stand desks in an occupational setting reduced lower-back discomfort (61). Therefore, although the latest evidence is suggestive that alternating periods of sitting with standing within occupational

settings does improve musculoskeletal health related to the lower back, **the EWG cannot support a recommendation that prolonged sedentary time be interrupted by standing.**

The most commonly used protocols in experimental studies have involved breaking prolonged sitting every 20 -30 minutes with 2-5 minute bouts of light-intensity physical activity. The experimental evidence to date could thus be seen to be indicative of a recommendation to break prolonged sitting with short bouts of light-intensity physical activity at least every 30 minutes. **However, there is insufficient prospective evidence to support such a recommendation.**

Question 4: Does current evidence suggest that sedentary behaviour should be considered an independent risk factor (independent of PA)?

Statement 4: For **young people**, evidence suggests that any negative health effects of sedentary behaviour are more likely to come from higher levels of TV and other screen time. Total sedentary time assessed with wearable devices suggest largely null or inconsistent associations. There is some evidence that negative health effects of sedentary time, and particularly TV/screen time, can be seen even when levels of MVPA are accounted for, but the association between sedentary behaviour and physical activity (MVPA) is small and not supportive of one directly replacing the other. This suggests that both sedentary time and physical activity need targeting. In **adults**, the evidence supports the conclusion that *both* increasing physical activity and reducing sedentary behaviour are important for metabolic, cardiovascular and cancer-related health outcomes. Evidence suggests that sedentary behaviour still has effects on health outcomes when MVPA levels are statistically controlled, but for those highly physically active, the effects are much less and may eliminate the detrimental association between sitting time and all-cause mortality. Few studies have been conducted specifically among populations of **older adults**, but the available evidence suggests there may be greater adverse health risks associated with sedentary behaviour for older adults who do not meet the physical activity guidelines.

Commentary 4: No large studies have assessed whether highly active young people are affected by high levels of sitting. In adults, a recent meta-analysis reported that high levels of moderate intensity physical activity (i.e., about 60-75 mins/day) appear to attenuate the increased risk of death associated with high sitting time (>8 hrs/day) (23). However, it should be noted that all studies, including this meta-analysis, suggest that the levels of fitness or MVPA that are needed to attenuate the associations/effects of sedentary time are high or very high, suggesting they do not apply to the majority of the population. The EWG do not think that the interplay between MVPA and sedentary behaviour should be considered as an “either/or” issue, since being physically active will affect many health behaviours, including sedentary behaviour. In addition to MVPA, the interactive role of light or vigorous-intensity physical activity, and other behaviours such as dietary factors and sleep need to be considered. Mechanistic evidence for an independent effect of being

sedentary is lacking.

Question 5: What are the data limitations and implications for surveillance for this area across age groups?

Statement 5: There are similar limitations to the data across **all age groups**. There are large discrepancies and inconsistencies in how researchers have measured sedentary behaviour (e.g., TV viewing, total sitting time) and possibly to a lesser extent, sedentary time using wearable devices. The former is limited by self-report of these behaviours, the latter by analytical decisions in managing objective sensor data. Important covariates such as physical activity, gender, SES and BMI are often not measured. The potential for reverse causation (increase in sedentary behaviour due to obesity or illness) is not often addressed. In addition, in **older adults**, there is a lack of research into the effects of sedentary time on geriatric-relevant health outcomes, and more research is needed in different settings such as hospitals and assisted living facilities, and among those over the age of 80yrs. The difficulty of measuring sedentary behaviour accurately substantially limits potential for surveillance.

Commentary 5: In adults, whilst a number of self-report measures have been shown to provide robust estimates of sedentary behaviour, the accurate capture of sitting, an increasingly ubiquitous behaviour, in population science is problematic and can lead to considerable exposure misclassification. This may undermine complete understanding of exposure-outcome associations. However it should be noted that the statistical effect of measurement error for exposure variables is to dilute rather than strengthen associations, therefore the associations with health outcomes reported in the literature are likely to be conservative estimates. Precision measurement of sedentary behaviour exposures (using accelerometers/inclinometers) and important covariates (for example PA, SEP, diet, adiposity), in combination with objective assessment of disease endpoints would provide further clarity on the dose-response relationships between sedentary behaviour and health outcomes. This would allow more precise prescriptive guidance for different population groups. In studies employing sensors, the variety of devices utilized and the diversity in techniques regarding data extraction and analysis across studies makes comparison difficult. Consensus is needed regarding the most valid approach to employ, and the methodological aspects of accelerometer studies need to be homogenized. The development of wearable devices that allow measurement of sleep, sedentary behaviour and physical activity over a 24hour period will allow a better understanding of the synergistic role of these behaviours in influencing a range of health outcomes.

Limitations of findings

- We used an ad hoc approach to the inclusion of papers beyond the systematic reviews identified by the central team, based on knowledge of group members
- We have not reviewed all original underpinning research and we have not been able to triangulate or repeat the original methods used.
- All reviews were limited to studies published in English and it may mean that key information published in other languages is missing.

Draft revision to the 2011 recommendations

Current recommendations state that people across the age range from 5-65+ years should “.....minimise the amount of time spent being sedentary (sitting) for extended periods” (5) or “.....avoid spending long periods sitting down” (7). The EWG has considered whether these recommendations can be quantified in terms of overall daily volume of sedentary time above which risk is increased, or by a frequency by which prolonged periods of sedentary behaviour should be interrupted to provide health benefits (see response to Question 3). Despite a general feeling in the EWG that it would be desirable to provide more specific guidance, we have concerns about the level of evidence to support these assertions, and the way in which they could be messaged.

Volume

We have considered whether the available evidence supports a recommendation for adults to limit time spent in total daily sitting to a specific value. This is discussed in commentary 3, and at present we do not think that such an amendment could be made.

Breaks

Although the experimental evidence supports that short breaks of at least light intensity physical activity are associated with acute metabolic health improvements, no long-term studies have shown improvements in health status with regard to morbidity or mortality. In terms of messaging, whilst we would be happy to suggest breaking sedentary time at least twice an hour – the frequency used in the majority of experimental studies - we feel that we could not answer the question of how long the breaks should be and how this interplays with the length of time between breaks. In addition, although standing may appear to be a practical method of breaking sedentary behaviour, its effectiveness in improving metabolic, cardiovascular or cancer-related health outcomes is not supported by current evidence.

Revised recommendation:

Children and Young people (5-18yrs) and all adults should aim to minimise the amount of time spent being sedentary and should break up long periods of sitting with at least light physical activity.

Note: This recommendation addresses the need to reduce sedentary time and replace it with light intensity physical activity. It acknowledges that the pattern of accumulation of sedentary time may be associated with poorer health, suggesting that long periods of sitting are broken up. However, it raises the questions of “what are long periods of sedentary time?” and “how frequently should these be broken up?”. A supporting commentary could suggest breaking sedentary time by light activity “at least every 30 minutes” as an indicator.

Note: This recommendation applies to Children and Young People (5-18yrs) and all adults. Under 5s were not considered in this consultation.

Note: Emerging evidence suggests that short regular bouts of light arm exercise whilst sitting or light resistance based exercise may result in reductions to postprandial glucose and insulin that are of similar magnitude as those promoted by light walking (66, 67), indicating that this recommendation may also be applicable to people unable to walk.

Although there are insufficient data to inform a recommendation, such findings and relevance to disabled individuals should be provided in supporting commentary.

Note: If sedentary behaviour is interrupted with physical activity of at least light intensity, then this will contribute to overall daily physical activity. The interaction between physical activity and sedentary time should be described in supporting commentary for the guidance (see Physical Activity Guidelines Advisory Committee 2018 (9)for an example).

Research recommendations

- Further studies are required to explore the association between interrupting sedentary time and health outcomes. These studies include research within prospective cohort studies, and longer-duration experimental studies with long-term follow up of health outcomes. Such studies will add to understanding of the chronic effects on metabolic, cardiovascular or cancer-related health of breaking up prolonged sedentary time in adults and inform understanding of the optimal pattern, level and duration of activity required for benefit.
- The evidence base to date is lacking/inconsistent on the possible mediators/moderators of the effects of sedentary behaviour on health outcomes in all age groups. Further studies should consistently address the influence of confounding or moderating factors such as physical activity/MVPA level, diet, sleep, BMI, sex on associations with health outcomes, ideally over the complete 24hour activity cycle.
- Further studies are required to explore interactions between sedentary behaviour and other behaviours, for example eating whilst watching TV, screen time before sleep, and how these impact health.
- There is a relative paucity of research in older adults, and in particular frail older adults. Further studies are required on sedentary time and outcomes such as cancer, pulmonary disease, mental health and geriatric syndromes in this population. No studies have investigated the combined effect of sedentary behaviour and physical activity on physical performance, frailty or mortality.
- The association between sedentary behaviour and cognitive function among adults and older adults is unclear. Studies in this area report equivocal findings, albeit overall being suggestive that sedentary behaviour is associated with reduced cognitive function over the lifespan. Research on this topic is complicated by the fact that some sedentary behaviours are cognitively engaging in nature, and may impact health differently to those that are more passive and less engaging.
- Methodological aspects of accelerometer studies need to be harmonized: there is currently no consensus on cut-points and analytical procedures for quantifying sedentary behaviour
- Consideration of the 24-hour activity cycle. Further studies are required to study the relationship between sedentary behaviour, sleep, and physical activity (of light/moderate/vigorous intensity) over the complete 24hour activity cycle, and associations with health outcomes.

Next steps

A second national consultation on the draft physical activity recommendations will be undertaken. This report will then be reviewed and edited where appropriate. A final technical report will then be produced for the UK CMOs with final recommendations for new physical activity guidelines. If the CMOs sign off the suggested recommendations, then the CMO Guidelines Writing Group will support the production of a final CMO Physical Activity Guidelines Report.

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