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Sedentary Behaviour and Mental Health in Children and Adolescents: A Meta-analysis

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Abstract

Background: A growing body of research is emerging examining the associations between sedentary behaviour and mental health in young people. The magnitude of the impact sedentary behaviour has on the mental health of young people has not been examined, though this has been investigated for physical health conditions. The aim of this article is to examine the associations between sedentary behaviour and mental health in young people aged 5-18 years of age using meta-analysis.

Methods: Published studies in the English language were located via manual and computerised searches of PubMed, Science Direct, SPORTDiscus, PsychINFO, Medline, Web of Science, Cochrane Library, and Google Scholar databases. Included were observational studies assessing an association between at least one sedentary behaviour and at least one aspect of mental health in young people aged 5-18 years. Effect sizes (ESs) were calculated for each study and an overall effect size was computed. Average effect sizes were also calculated for moderator variables.

Results: Thirty-five studies were included (n=373,512); most studies examined screen-time as sedentary behaviour and five mental health outcomes were identified (depression, anxiety, self-esteem, psychological distress, and quality of life). The summary effect was small and significant (ES = -0.30, 95% confidence intervals = -0.20, -0.45, p<0.001), suggesting that sedentary behaviour is negatively associated with mental health in young people. Moderator analysis showed that television viewing had the largest effect size (ES = -0.47, 95% confidence intervals = -0.35, -0.62, p<0.001). Moreover, depression seems to be the main mental health outcome affected by sedentary behaviour (ES = 0.55, 95% confidence intervals = 0.42, 0.68, p<0.001).

Conclusions: There was a small but a significant negative association between sedentary behaviour and mental health. High levels of sedentary behaviour are associated with increased depressive symptoms. This finding is consistent with a systematic review on adults which indicated that sedentary behaviour is significantly associated with mental health problems.

Keywords: Sedentary behavior; Sitting time; Screen; TV; Video game; Computers games; Mental health; Depression; Anxiety; Stress; Psychological distress

Background

Mental health is a complex part of cognitive neuroscience influenced by different factors such as biopsychosocial –i.e. biological, psychological, social and environmental systems [1]. Individual lifestyles have become a central focus in healthcare since population patterns of ill health have changed from contagious to lifestyle diseases [1,2]. It is well established that physical activity is associated with positive health in all populations. The health benefits of physical activity have led to the development of physical activity guidelines for adults and young people [3]. Research has shown that many young people are not meeting the physical activity guidelines [3-5]. In addition, more recent research suggests that many young people spend large proportions of the day in sedentary pursuits. Sedentary behaviour has been defined as any waking behaviour in which energy expenditure is ≤1.5 METs while in a sitting or reclining position, and includes behaviours such as watching television, travelling by car/public transport, sitting in class, playing computer games etc. [6]. Sedentary behaviours have increased among young people partly due to the technological development of attractive home-based entertainment devices, homework and leisure use of computers, and high levels of sitting at school, with or without computer screens [4]. Therefore, during leisure time a number of adolescents, especially boys, sit to play video and computer games. Girls also use the computers for diverse reasons, including social contact and shopping [7,8]. Television is the most common entertainment device which is available in most homes and is widely used by young people [9]. However, the computer/internet is the most valued media among young people because of the wide variety of its use including e-mail, social networking, playing games, watching movies, and searching information [10]. In modern society, the use of screen-entertainment devices are often thought to replace active games among adolescents [4], although precise data are lacking.

Recent research has shown that high levels of sedentary behaviour in young people can have a negative impact on their health. High levels of sedentary behaviour have contributed to the increase in chronic

diseases such as obesity, type 2 diabetes and heart problems among adolescents [11-14]. Young people are therefore predisposed to health problems through multiple unhealthy lifestyles including physical inactivity (low levels of physical activity) and sedentary behaviour (high levels of sitting).

An aspect of health which has received considerable attention by researchers and public health professionals is mental well-being [2,15,16]. Mental health difficulties have become common among young people, especially adolescents. It has been estimated that every year about 20% of adolescents suffer mental health problems including depression, anxiety, low self-esteem and major mental illness. The most common of these problems among adolescents is depression [16]. The rise in mental health problems among young people could dramatically increase health care costs [3]. Moreover, mental health problems may affect school attendance and create learning problems for young people [17].

Due to the increasing prevalence of mental health problems in young people, researchers have been investigating possible contributing factors. There is a need for preventing and controlling mental health problems. While physical activity and mental well-being has been studied extensively in adults, but less in young people [18], there is currently no synthesis of evidence aggregating findings on sedentary behaviour and mental health in young people. Therefore it is timely to review the evidence. The aim of this paper, therefore, is to examine the association between sedentary behaviour and mental health in young people using meta-analysis.

Methods

Literature search

Papers were searched using key terms indicating: 1) sedentary behaviour (e.g., sedentary, television, video, DVDs, computers, screen-time and sitting); 2) mental well-being outcomes (e.g., mental health, psychological well-being, health related quality of life, quality of life, depression, stress, anxiety and self-esteem); and 3) youth population (e.g., children, adolescents, teenagers and young people). PubMed, Science Direct, SPORTDiscus, PsychINFO, Medline, Web of Science, Cochrane Library and Google Scholar databases were searched using the specified key terms.

Inclusion and exclusion criteria

To be eligible for inclusion the study must: 1) include children and/or adolescents aged 5-18 years; 2) have a quantified measure of sedentary behaviour (studies that measured the content rather than quantity of time consuming screen-based sedentary behaviour, such as aggressive movies, horror films, etc., were excluded); 3) have a measured mental health outcome as specified in the key terms list; 4) provide a quantified association between at least one sedentary behaviour and one mental health outcome; 5) be published in a peer-reviewed journal in the English language up to June 2012.

Data extraction and coding

Information from the studies included were extracted onto standardised forms developed for this review. Information extracted from each of the studies included: authors of the paper, country of study, type of study, type of population, sample size, age range of the sample, response rate, type of sedentary behaviour assessed, mental health outcome assessed, and validity and reliability of measures used to assess sedentary behaviour and mental health. Some authors of the papers were contacted for clarification of some information when necessary.

Quality assessment of the papers included

The quality of all the studies were evaluated mainly based on their methodological strengths using a checklist [19,20]. The criteria evaluated included the sampling procedure, inclusion of adequate sample size, tools for assessing the constructs being investigated, and statistical analyses. Similar criteria were used to evaluate both cross-sectional and longitudinal studies, but longitudinal studies were evaluated with additional two items. Specifically, the criteria for evaluating longitudinal studies included additional items that evaluated adequate response rate at follow up and appropriate description of follow up duration or assessment. Thus, the total score for the quality grading was 11 points for cross-sectional studies and 13 points for longitudinal studies. In this meta-analysis, studies that obtained scores equal to or above the mean score were classified as high quality whereas studies with scores below the mean score were classified as low quality studies.

Data coding

Studies included in the meta-analysis were coded on a number of characteristics, based on hypothesised moderators. Specific information on coded variables was based on study design and coded as cross-sectional or longitudinal. Age group of the participants were coded as children (ages 5 to 11 years), adolescents (ages 12 to 18 years), or a combined sample of children and adolescents (ages 5 to 18 years). Gender was coded as boys only, girls only; and boys and girls. Studies were coded for the type of screen assessed in order to compare the impact of particular screen use on mental well-being. Coding included television, computers, video/DVDs, screen, and sedentary behaviour. Indicators of mental well-being were coded as anxiety, depression, self-esteem, psychological distress, and quality of life. Irrespective of the research designs of the studies included, the quality of the methods and style of reporting findings were evaluated. Thus, studies were coded as high quality or low quality based on the criteria described above.

Statistical analyses

The Comprehensive Meta-Analysis (CMA) version-2 software was used to calculate effect sizes for the relationship between sedentary behaviour and mental well-being. The effect sizes for the individual studies were computed. An overall effect size was calculated for all the studies. The effect size was expressed as Hedges' g. The effect of heterogeneity was estimated using the Q measure. Where the test of heterogeneity was significant, it meant that there was a need to examine moderator variables. Some moderator variables hypothesized before the meta-analysis included: i) the research design, ii) age group of participants, iii) type of sedentary behaviour, iv) mental health outcome and v) study quality. The magnitude of the effect sizes were assessed using Cohen's [21] criteria: small = 0.2-0.49; moderate = 0.5-0.79; and large = ≥0.08.

Results

Identification of relevant studies

Potentially relevant articles were selected by (1) screening the titles; (2) screening the abstracts; and (3) if abstracts were not available or

did not provide sufficient data, the entire article was retrieved and screened to determine whether it met the inclusion criteria. A customised 'in-out' form was used to appraise the studies for inclusion or exclusion. This led to 69 papers being excluded and 35 papers included for the meta-analysis. The screening process followed the PRISMA guidelines [22]. The screening procedure is shown in Figure 1.

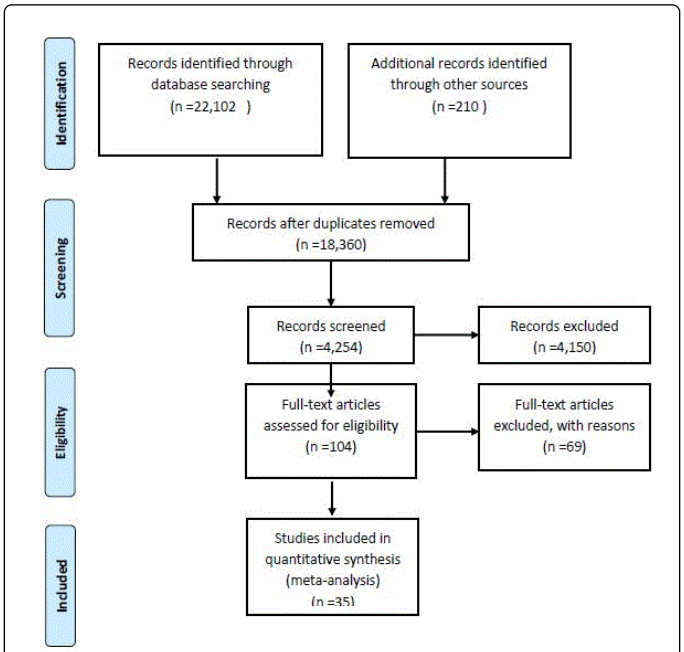

Figure 1: Meta-analysis screening process.

Study characteristics

The studies included were mainly conducted in the U.K, U.S., Canada, Germany and China. Almost all the studies examined screen-based sedentary behaviour. Only about two studies [23] assessed total sedentary behaviour. The majority of the studies used the Centres for Epidemiologic Studies Depression scale to measure depression [24-26]. Only some few studies used a clinical diagnostic tool such as the Beck Depression Inventory to measure depression. A number of the studies used the Strengths and Difficulties Questionnaire to measure mental health [27,28]. Moreover, most of the studies used the physical self-perception scale to assess self-esteem.

Participant characteristics

Studies included 373,512 young people. Participants were boys and girls aged 5 to 18 years who were attending schools. The majority of the studies included both children and adolescents. Some of the studies included only children. However, very few studies focused solely on adolescents.

Quality assessment

Generally the quality of the studies included was quite poor. This was mainly because a significant number of the studies did not use validated tools to measure sedentary behaviour and mental health. Some of the studies also measured mental well-being by proxy reports which may not accurately represent the children's mental well-being. Three studies were rated the highest score of 8 out of 11 points. A significant number of studies obtained lower scores ranging from 5 to 3 points (Table 2).

Meta-analysis

Overall effect size

The mean overall effect size for the association between sedentary behaviour and mental well-being was small but significant (ES = -0.30, 95% confidence intervals = -0.20, -0.45, $p<0.001$; K=37; n=373,512) (Cohen, 1988). The test of heterogeneity was also significant [Q (36) = 20706.43, $p<.001$], therefore potential moderators of the association between sedentary behaviour and mental well-being were examined. The Q values, significant levels and the effect sizes of the moderator variables are presented in Table 1.

Effect Sizes for Moderator Variables

Design

Both types of research design had significant effect sizes. Cross-sectional studies had a larger effect size than longitudinal studies, although the latter had only 4 studies (Table 1).

Moderator Variable	Q	df	Level	ES	95% CI	n	p
Study Design							
Cross-sectional	20403.77	32	p<0.001	0.30	0.21, 0.42	33	*
Longitudinal	5.83	3	p>0.05	0.05	0.03, 0.16	4	**
Type of Sedentary behaviour							
TV	898.44	6	p<0.001	0.47	0.35, 0.62	7	*
Computers/internet	159.32	9	p<0.001	0.10	0.05, 0.21	10	*
Video/DVDs	10.22	2	p>0.05	0.21	0.10, 0.34	3	*
Screen	6919.82	5	p<0.001	0.51	0.34, 0.65	6	*

Total sedentary	3.05	1	p>0.05	0.05	-0.02, 0.10	2	n.s
Mental well-being outcome							
Anxiety	6.99	4	p>0.05	0.31	0.14, 0.45	5	*
Depression	2206.49	9	p<0.001	0.55	0.42, 0.68	10	*
Self-esteem	10.95	7	p>0.05	0.01	-0.01, 0.02	8	n.s
Psychological distress	1812.87	3	p<0.001	0.41	0.30, 0.56	4	*
Quality of life	73.50	2	p<0.001	-0.15	-0.12, -0.23	3	*
Study quality							
High	18757.05	19	p<0.001	0.31	0.20, 0.45	20	*
Low	268.52	16	p<0.001	0.03	0.02, 0.04	17	n.s
*p<0.001 **p<0.05							

Table 1: Homogeneity tests and effect sizes for moderator variables.

Subject characteristics

Most of the studies that have investigated sedentary behaviour and mental well-being have not reported effects separately for children and adolescents. Therefore, we could only provide effect sizes for children and adolescents combined.

Type of sedentary behaviour

All types of sedentary behaviour were significantly associated with mental well-being except total sedentary behaviour (ES = -0.05, 95% confidence intervals = -0.03, 0.10, p>0.05). The largest effects were seen for general screen use (ES = -0.51, 95% confidence intervals = -0.34, -0.65, p<0.001) and television viewing (ES = -0.47, 95% confidence intervals = -0.35, -0.62, p<0.001).

Measures of mental well-being

The largest effects were seen for depression (ES = 0.55, 95% confidence intervals = 0.42, 0.68, p<0.001) and psychological distress (ES = 0.41, 95% confidence intervals = 0.30, 0.56, p<0.001). The smallest effects were identified for anxiety and quality of life. However, there was no significant effect for self-esteem.

Study quality

Only the high quality studies had significant effects (ES = -0.31, 95% confidence intervals = -0.20, -0.45, p<0.001).

Study	Sample Characteristics	Design/ method	Sedentary behaviour exposure variable	Mental Well-being outcome variable	Results	Study quality
Fling et al. [46]	N = 153 children and adolescents from middle and junior high schools. Boys and girls of 11 to 18 years old.	Cross-sectional	Video game playing	Self-esteem	There was a significant but small positive association between sedentary behaviour and self-esteem.	5
Colwell et al. [47]	N = 120 English school children and adolescents. Boys and girls aged 11 to 17 years.	Cross-sectional	Television viewing and computer game playing	Self-esteem	Sedentary behaviour was significantly associated with low self-esteem in girls. A moderate association was determined.	4
Colwell et al. [48]	N = 204 English school children and adolescents. Boys and girls aged 12 to 14 years.	Cross-sectional	Computer game playing	Self-esteem	A significant but small negative association between sedentary behaviour and self-esteem.	4
Durkin et al. [36]	N = 1304 adolescents in the U.S. Boys and girls aged 16 years.	Cross-sectional	Computer game playing	Depression and Self-esteem	Low use of computer games was significantly associated with lower depression and higher self-esteem than high use and	4

					non-use of computer games.	
Schmitz et al. [26]	N = 3798 students from sixteen schools in the U.S. Boys and girls of 11 to 15 years.	Cross-sectional	Television viewing and video game playing	Depression	Sedentary behaviour was positively associated with depression.	7
Murdey et al. [23]	N = 119 children and adolescents from two schools in the U.K. Boys and girls aged 10 to 15 years.	Cross-sectional	Sedentary behaviour	Self-esteem	A significant but small negative association between sedentary behaviour and body image in girls.	8
Singer et al. [49]	N = 2245 students from eleven schools in U.S. Boys and girls from 7 to 15 years.	Cross-sectional	Television viewing	Anxiety	A significant but small positive association between sedentary behaviour and anxiety.	5
Chen et al. [50]	N = 7887 junior high school students from Japan. Boys and girls of 12 to 13 years.	Cross-sectional	Television viewing	Quality of life	Longer duration of television viewing was significantly associated with poor quality of life.	7
Lohaus et al. [51]	N = 357 German students. Boys and girls aged 10 to 14 years	Cross-sectional	Television viewing and computer use	Anxiety	A significant but small positive association between media use and anxiety.	7
Ybarra et al. [52]	N = 1501 children and adolescents from the U.K. Boys and girls from 11 to 16 years.	Cross-sectional	Internet use	Depression	Internet use for ≥3 hours a day was significantly associated with higher depression.	5
Goldfield et al. [53].	N = 30 Canadian children. Boys and girls of 8 to 12 years.	Cross-sectional	Television viewing	Self-esteem	A significant negative relationship between sedentary behaviour and physical self-worth and global self-esteem. A moderate association determined.	6
Ha et al. [54]	N = 452 Korean adolescents. Boys and girls.	Cross-sectional	Internet use	Depression	A significant and strong positive relationship between excessive internet use and depression.	7
Ussher et al. [28]	N = 2623 adolescents from ten schools in the U.K. Boys and girls of 13 to 16 years.	Cross-sectional	Screen use (TV, Computer, Video game)	Psychological distress	A significant and strong positive association between higher sedentary behaviour and psychological difficulties.	6
Comer et al. [38]	N = 90 children and adolescents from Philadelphia. Boys and girls aged 7 to 13 years.	Cross-sectional	Television viewing and internet use	Anxiety	A significant and moderate positive relationship between internet use and anxiety.	8
Selfhout et al. [56]	N = 307 Dutch adolescents. Boys and girls.	Longitudinal	Internet use	Depression and anxiety	Use of internet was not significantly associated with depression or anxiety over time.	6
Van et al. [57]	N = 663 students from Holland. Boys and girls of 12 to 15 years.	Longitudinal	Internet use	Depression	A strong positive relationship between internet use and depression.	6
Hamer et al. [58]	N = 1486 Scottish children aged 4 to 12 years.	Cross-sectional	Television	Psychological distress	Higher screen use was significantly associated with higher psychological difficulties.	6

Holder et al. [59]	N = 375 Canadian school children of 8 to 12 years. Boys and girls.	Cross-sectional	Screen use (Television, computer and video games)	Happiness and self-esteem	A small negative association between screen use and happiness. A small negative association between screen use and body image.	4
Iannotti et al. [60]	N = 204534 students from ten countries in Europe and America. Boys and girls of 11 to 15 years.	Cross-sectional	Screen use (Television, computer and video games)	Self-esteem and quality of life	A small but significant negative association between screen use and self-esteem and quality of life.	7
Iannotti et al. [61]	2 samples. N = 22084 school children from 40 countries in the U.S. and Canada. Boys and girls.	Cross-sectional	Screen use (Television, computer and video games)	Self-esteem and quality of life	A small but significant association between screen use and self-esteem and quality of life.	6
Mathers et al. [62]	N = 925 adolescents. Boys and girls of 13 to 20 years.	Cross-sectional	Screen use (Television, computer, video games)	Psychological distress	Longer use of screen was significantly associated with higher psychological difficulties.	9
Primack et al. [25]	N = 4142 adolescents from multi-ethnic cultures including Europe, America and Asia. Boys and girls.	Longitudinal	Screen use (Television, computer and video games)	Depression	Longer television viewing was significantly associated with the likelihood of higher depression at follow-up.	7
Russ et al. [63]	N = 54863 children and adolescents in the U.S. Boys and girls of 6 to 17 years.	Cross-sectional	Television viewing and computer use.	Self-esteem	Each hour of television viewing was significantly associated with 8% likelihood of low self-esteem.	6
Choo et al. [41]	N = 2998 children and adolescents from Singapore. Boys and girls from primary and secondary schools.	Cross-sectional	Video game playing	Anxiety	Excessive video game playing was significantly associated with higher anxiety symptoms.	5
Dumith et al. [64].	N = 4452 adolescents from Brazil. Boys and girls.	Cross-sectional	Screen use (Television, computer and video games).	Happiness	Screen use was significantly and inversely associated with happiness.	5
Griffiths et al. [27]	N = 13470 children in the U.K. Boys and girls of 3 to 5 years.	Cross-sectional	Screen use (Television, computer and video games)	Psychological distress	Longer hours of screen use were not associated with psychological difficulties in very young children.	4
Katon et al. [65]	N = 2291 adolescents in the U.S. Boys and girls aged 13 to 17 years.	Cross-sectional	Television viewing and computer use	Depression	Excessive computer use was significantly associated with higher depression.	7
Page et al. [66]	N = 1013 school children from twenty-three primary schools in the U.K. Boys and girls of 10 to 11 years.	Cross-sectional	Television viewing, computer use and total sedentary behaviour.	Psychological distress	Greater television and computer use was significantly associated with higher psychological difficulties. However, overall sedentary time, assessed with accelerometer, was significantly associated with better psychological well-being.	5

Cao et al. [67]	N = 5003 Chinese children and adolescents. Boys and girls aged 11 to 16 years.	Cross-sectional	Screen use (TV, and computer)	Depression, anxiety and quality of life.	There was a significant positive relationship between sedentary behaviour and depression, anxiety. Sedentary behaviour was also associated with life dissatisfaction.	8
Deyreh et al. [42]	N = 231 elementary students in Iran. Boys and girls.	Cross-sectional	Computer use and video game playing.	Psychological distress	There was a significant positive association between sedentary behaviour and psychological difficulties.	3
Holtz et al. [68]	N = 205 students from Austria. Boys and girls of 10 to 14 years.	Cross-sectional	Internet use and video game playing.	Anxiety	Excessive internet use was significantly associated with anxiety symptoms.	6
Jackson et al. [69]	N = 482 school children from the U.S. Boys and girls.	Cross-sectional	Screen use (internet and video games)	Self-esteem (social self-esteem and overall self-esteem)	Only internet use was significantly associated with low social and overall self-esteem.	8
Lemola et al. [24]	N = 190 students from Switzerland. Boys and girls aged 13 to 17 years.	Cross-sectional	Computer use	depression	Longer duration of computer use especially at night was significantly associated with depression.	4
Messias et al. [70].	2 separate samples. N = 30451 U.S students. Boys and girls of 14 to 18 years.	Cross-sectional	Internet use and video game playing.	Depression (suicidal ideas)	Students who used the internet or play video games for 5 hours or more per day had higher risk of sadness and suicidal ideas.	5
Sund et al. [71]	N = 2464 school children and adolescents in Norway. Boys and girls aged 12 to 15 years. .	Longitudinal	TV viewing, video game playing and reading.	Depression	Higher amount of time spent in sedentary activities significantly predicted depression a year later.	8
Note: Study quality was scored over 11 points for cross-sectional studies and 13 for longitudinal studies.						

Table 2: Summary Table of Studies Included in the Meta-analysis and Study quality ratings.

Discussion

This meta-analysis is the first to evaluate the association between sedentary behaviour and mental well-being in young people. Studies indicate a small but significant negative association between sedentary behaviour and mental health when assessing mainly screen-based sedentary behaviour and various indicators of mental health. Our findings are consistent with a systematic review with adults showing that sedentary behaviour is associated with higher levels of depression in adults [29]. The present findings are also consistent with those finding that sedentary behaviour influences physical well-being independent of physical activity levels [30,31].

All types of screen use, except video/DVD use, were significantly associated with poorer mental health among young people. Among the kinds of screen assessed, television use had the largest association with mental health compared to computers and video games. Research findings indicate that the main period in which young people are sedentary is after-school hours when they have returned home [32]. With television being the most common entertainment device at home [33], young people are more likely to use television for leisure activity than other kinds of screen. For example, it has been indicated that about 60% of young people have television in their bedrooms [34], which suggests that these young people are more likely to watch television after school hours.

Particularly, television use had a larger association with mental health problems than computers. The possible explanation for this finding is that TV viewing involves less stimulation of the brain, compared to computer use therefore making it more associated with mental health problems. Using computers, however, may involve much more mental stimulation due to activities such as typing on the keyboard, using the mouse, clicking buttons, etc. which may distract the user from worrying and therefore reduce mental health problems.

It should also be noted that when not accounting for television, the highest effect size occurred for combined screen use. There is the possibility that the larger effect size for combined screen use was associated with television use than other kinds of screen. However, total sedentary behaviour was not significantly associated with mental health. This finding was not surprising because few studies have assessed overall sedentary behaviour and only 2 studies were assessed here. Moreover, since total sedentary time was associated with poor mental well-being but not significant, it also suggests that perhaps

screen use constitutes the main aspect of sedentary behaviour in young people than other aspects of sedentary behaviour associated with reading, sitting to chat without screen and travelling. Strasburger [10] mentioned that young people spend a greater proportion of their leisure time using screen devices than any other activity.

Regarding the indicators of mental well-being, depression has the largest effect compared to the other measures of mental well-being. Furthermore, sedentary behaviour was not associated with self-esteem. This finding contradicts studies which have shown that depression is highly associated with self-esteem [35]. Based on the evidence that individuals who are depressed are more likely to experience self-esteem problems, it was expected that sedentary behaviour would be associated with self-esteem as well. However the current finding is supported by studies which have showed that the use of some screens is associated with improved self-esteem among young people [36].

Specifically some studies have found that the use of computer is associated with improvement in social self-esteem [8,37]. Moreover, in the present findings computer use had a smaller impact on depression. Therefore it could be that young people who used computers experienced some improvement in some aspects of their self-esteem [37] which resulted to a reduction of the possible impact that computer use might have on depression. This is because improvement in self-esteem significantly reduces depression [35,38]. It should however be noted that the use of computers have been associated with social self-esteem, but not other domains of self-esteem [37].

Concerning the age group of the young people examined, the lack of studies assessing children and adolescents separately did not allow for a comparison of the impact of sedentary behaviour on these two age groups. Given that findings indicate that adolescents are more likely to be sedentary than children [39] and adolescents are more prone to depression than children [40], it is important to determine the extent to which sedentary behaviour separately might differentially affect both children and adolescents.

Among the studies that have assessed sedentary behaviour and mental well-being, nearly half (46%) were of low quality. Interestingly, the high quality studies showed larger effects than the low quality studies. It is important to note that the significant number of low quality studies that have assessed sedentary behaviour and mental well-being in young people might be the reason why a small effect was determined for the overall association between sedentary behaviour and mental well-being. Specifically, a number of the studies did not use standardised tests to measure mental well-being [41,42].

Limitations of the Findings

The findings reported in this meta-analysis have some limitations. Specifically, the data are based on rather few studies, the majority of which have methodological limitations, including being mainly cross-sectional where reverse causality cannot be ruled out. For example, there is evidence that people who are depressed may participate less in physical activities [38,43]. Participating in less physical activity may increase the likelihood of being sedentary [44]. Moreover, having poor mental health may predispose one to sit more. In addition, studies that were examined assessed mainly screen use, therefore the findings does not show the impact of the entire range of sedentary behaviours on young people's mental well-being. Young people also engage in multiple sedentary behaviours in different settings [44].

Implications of the Findings

This meta-analysis supports the sedentary behaviour guidelines [3]. The government and the public health agencies need to take account of physical activity and sedentary behaviours in their agenda when promoting health among young people. School physical education, which is an important subject that would expose students to physical activity and reduction in sedentary behaviours should be well structured. Introducing structured physical activities into mental health care is likely to reduce sedentary behaviour [44] and facilitate recovery [45-50].

Conclusion

Few studies have investigated sedentary behaviour and mental well-being in young people. There is a need for additional studies, especially among adolescents. Studies which investigate sedentary behaviour among young people should provide separate results for children and adolescents [51-65]. Moreover, studies investigating sedentary behaviour need to assess a greater variety of sedentary behaviour contexts in order to determine the association between different sedentary behaviours and mental well-being. There is a need for longitudinal, prospective and experimental designs to further examine the impact of sedentary behaviour on mental well-being. This area of research has not been investigated with experimental studies and it is only these that will resolve the issue of whether reverse causality is at play [65-71]. In summary, a small but significant negative effect has been shown between sedentary behaviour and mental well-being. Sedentary behaviour is most clearly associated with depression among young people. This finding is in line with reports stating that depression is the most common mental well-being problems experienced by young people [16].

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