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**Do Intervention Studies to Promote Physical Activity
and Reduce Sedentary Behavior in Children and
Adolescents Take Sex/Gender Into Account?**

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List of Abbreviations

e.g. exempli gratia: “for example”

et al. et alii: “and others”

PA Physical Activity

SB Sedentary Behavior

Summary

All over the world, sex/gender-related inequalities exist, also in physical activity domains. The prevalence of physical activity in children and adolescents is generally low but compared to boys, girls are less physically active in childhood and youth. This circumstance is problematic because physical inactivity is associated with mental health issues and chronic diseases. In order to promote physical activity and/or to reduce sedentary behavior in children and adolescents in general and to understand why girls are less physically active than boys in particular, it is of importance to examine sex/gender inequalities. As many interventions aiming to promote physical activity and/or reduce sedentary behavior in this stage of life provided only limited effects, whereby the cause has remained unclear, it should be examined if and to what extent these intervention studies have considered sex/gender.

Therefore, this thesis establishes an innovative approach to assess the consideration of sex/gender in systematic reviews that give an overview of intervention studies aiming to promote physical activity and/or reduce sedentary behavior in children and adolescents. First, a sex/gender checklist was developed that helps (a) to assess the degree of consideration of sex/gender in studies in systematic reviews and (b) develop, implement, and evaluate interventions. Based on this checklist, 217 intervention studies aiming to promote physical activity and/or reduce sedentary behavior in the school setting were reviewed and assessed in terms of considering sex/gender in planning, implementation and evaluation of an intervention. Additionally, meta-analyses of school-based intervention studies were conducted that examined the interventions' effectiveness

with a particular focus on sex/gender. The meta-analyses found that the interventions had significant but relatively small effects on both girls and boys and high heterogeneity.

The established sex/gender checklist provides a firm foundation for the development, implementation, and evaluation of future gender-sensitive interventions aiming to promote physical activity and/or reduce sedentary behavior. Furthermore, it provides a guideline for researchers on how to systematically report and evaluate study information in order to answer sex/gender-related research questions.

1 Introduction

Female emancipation is developing well in many areas of daily life but some areas remain where women are often discriminated. In the development of medical treatment, women are still less likely enrolled than men (Mazure & Jones, 2015). Car crash tests are mainly conducted with male dummies, so women are more likely to suffer life-threatening injuries in accidents (Gjengedal, 2019). In research, men publish more articles than women, which illustrates the existent sex/gender gap. In Germany, the ratio between publishing female and male authors was around 0.47, in Europe around 0.63 (Krapp, 2020). This shows that many sex/gender differences are not given and fixed by nature, but are made and continually remade by humans. These sex/gender differences are a social construct that changes with culture (Schabert, 2021).

Girls and boys are different in their behavior and in particular their physical activity (PA) behavior. Girls are more likely to be physically inactive than boys (Guthold et al., 2020). These differences are partly historically developed and anchored in society. However, these differences are also biological in origin. There are several definitions, theories and explanations for different sex/gender behaviors, depending on whether it is defined by a biological, scientific, sociocultural or political perspective. From a scientific point of view, the biological dichotomous is primarily divided into male and female. The natural science view of sex/gender difference has formed the basis of everyday life-world knowledge of gender difference as a natural fact since the late 18th century until today, and the critical reconstruction of this dynamic is a constitutive topic of sex/gender studies. This mainly natural science view has always been controversial. This is also

because the dimension 'sex', understood in the narrow sense as purely biological, as well as the ostensibly purely social 'gender', are empirically not so clearly separable from each other, nor so clearly dichotomous (Villa, 2019).

However, the purely scientific view is not sufficient. Schwarzer (1975) expresses that biology is not equal to destiny. The feminist approach puts an emphasis on the separation of the social and the biological, of nature and culture, and thus of sex and gender. In research and politics, the disconnection between biology and the social, 'sex' and 'gender', has been about questioning the deterministic causality between the two (Villa, 2019). Because sex and gender are inseparably linked with each other we use the term sex/gender (Doull et al., 2014).

As the lack of PA is the fourth leading cause of death worldwide, it is of particular importance to promote an active lifestyle (World Health Organization, 2009). A sufficient amount of PA can also have an impact on health, since PA prevents physical and mental illnesses (Biddle et al., 2019; Warburton & Bredin, 2017). Furthermore, this behavior in childhood and youth is particularly worrying, as PA behavior is often transferred from childhood and adolescence into adulthood. This so-called tracking effect means that active healthy children and adolescents are highly likely to become active healthy adults (Telama et al., 2013).

Therefore, it is important to start at an early age and to encourage children and adolescents to adopt an active lifestyle. The school offers an appropriate setting for interventions, as children and adolescents of all socio-economic backgrounds can be reached. PA depends on many different motivational factors, but also on environmental factors such as school, which influences the behavior of children and adolescents (Bachner et al., 2020; Kelso et al., 2020). However, only

about 50% of schools worldwide are able to create an environment for sufficient PA on school days (Aubert et al., 2018).

For these reasons, interventions to promote PA in different settings have been carried out for years. Many interventions tried to increase the amount of PA in boys and girls as well as to decrease the differences between sex/gender. Many of these interventions are successful in promoting PA mostly with small effects, but could not decrease the difference in between boys and girls (Love et al., 2019).

Until today, no systematic review has analyzed the extent to which sex/gender has been addressed in the development, implementation and evaluation of interventions promoting PA. This dissertation therefore evaluates 217 intervention studies aimed at promoting PA or reducing SB in childhood and adolescence with regard to their treatment of sex/gender. A newly sex/gender checklist was used to assess this handling. In a second step, school-based interventions were examined in detail with regard to outcomes and effectiveness for boys and girls.

Two publications present results of the innovative newly developed sex/gender checklist and the results of the meta-analyses of the school interventions.

1.1 Physical Activity Differences in Girls and Boys

In fact, girls aged 11-17 years worldwide less likely achieve the recommended PA levels than boys (Cooper et al., 2015; Guthold et al., 2020; Hallal et al., 2012). With 22% boys reached the recommended daily PA much more frequently than girls with 15% (Guthold et al., 2020; World Health Organization, 2019). For boys, the prevalence of physical inactivity has decreased from 2001 until

2016 from 80.1% to 77.6%. For girls, however, there was no significant change in the same timeline (85.1% to 84.7%). So worldwide there is a significant difference in insufficient PA behavior between boys and girls of 7.1 percentage points in 2016 (Guthold et al., 2020).

A recent study in Norway with 1,202 participants showed that girls are significantly more into physical activities like dancing, gymnastics, exercising to music, jumping or rope skipping (Resaland et al., 2019). Boys are more interested in team handball, climbing, swimming/water play, mountain hiking or soccer (Resaland et al., 2019). Furthermore, girls tend to be less active in sports clubs. Among 7-14 year olds in Germany, girls are significantly less likely (57.1%) to be members of a sports club than boys (75.0%) (Statista, 2021). The gender gap increases with age. In the age group of 15-18 year olds, both boys (64.3 %) and girls (45.7 %) are less frequently members of a sports club than the younger ones (Statista, 2021).

Girls tend to be introduced to interdisciplinary forms of movement (e.g. playing ball, jumping, climbing, swinging), which are generally less space exploring and competition-oriented. Instead of forms of exercise that require direct opposition, cooperative games dominate. There is also a tendency to include girls in aesthetic-expressive forms of movement rather than, e.g., in contact sports. The motor skills promoted by these movement activities, as well as the experiences linked to these movement contexts, are correspondingly different from those of boys (Hunger, 2007).

1.2 Where do the Sex/gender Differences come from

1.2.1 *Historical background – Sex/gender and Sports*

Since the beginning of sports and exercise sex/gender has always played a major role and it still continues to have a huge impact today. In ancient times, only men were allowed to play sports and participate in the Olympic Games (Bengtson, 1983). At the beginning of the 19th century, one of the first German sports educators Johann Christoph Friedrich GutsMuths noted that inactivity would have bad consequences for men and that, in addition to intellectual education, the body would be neglected (GutsMuths, 1801). Therefore, he recommended gymnastics for boys. On the one hand, the characteristics of strength, speed and discipline were attributed to masculinity. Furthermore, sports were supposed to strengthen potential soldiers. In contrast to strong men, women were referred to as weak, receptive and yielding. This was already postulated by Rousseau in 1762 (Rousseau, 1993). Man and woman were considered opposites that complemented each other. There was no place for women in sports education, as sports were seen as a threat to women's beauty and health.

In the middle of the 19th century, Moritz Kloss drew attention to the fact that PA is also beneficial for girls and women (Kloss, 1862). Nevertheless, a distinction was made between sports for men and women. Sports for women had to be useful and enjoyable. Thus, aesthetic sports such as gymnastics, games and dance were considered feminine. Running-, throwing- and setbackgames, which involved strong exertion, were not considered for women not to exceed a light exercise (Kloss, 1862). In Germany, the main reason for the resistance to gymnastics and sports for girls was the defense of the existing gender order (Pfister, 2017).

At the end of the 19th century, women began to participate in the first competitions in biking or rowing, which also marked the beginning of emancipation in sports. Nevertheless, it was still widespread in society that competition and exertion did not suit women (Rohner, 2018). Nevertheless, women were only accepted in a few sports, such as tennis, golf, or horse riding. Due to apparent excessive demands on the weaker sex/gender, the rowing and cycling competitions were cancelled again (Hutmacher, 2010; Kuhn, 1995). Along with the social changes at the beginning of the 20th century, women from certain social classes were able to get into employment as well as begin their university studies (Pfister, 2017). Women continued to fight for emancipation in sports. Largely unnoticed by the public, some women were able to participate in a few disciplines at the 1900 Olympics, but this remained an exception (Pfister, 2013).

At the beginning of the 20th century, women were allowed to participate in more and more sports, but were excluded from competitions. Still the endangerment of femininity and the possible change of the aesthetic female body were discussed (Pfister, 2013). In the following years, women's sports were slow to establish themselves. Nevertheless, female athletes, physicians, gymnastics teachers and Women's Sports Journals were able to promote women's sports (Pfister, 2017). Thus, the prestige of sports for women grew, women were able to participate more and more often in world competitions in various sports, and there were also more and more female athletes at the Olympic Games of the following years. Nevertheless, criticism was not eliminated (Pfister, 2000). During the Second World War, sport was instrumentalized to prepare young men for military service. Women, however, were strongly pressed into the classic gender roles (Czech,

1994). After the Second World War, equal rights for men and women were anchored in the German constitution. Nevertheless, traditional gender roles remained in families and society (Pfister & Langenfeld, 1982). Public discourse on women's sports has also been influenced by a new edition of the *polarity theory*, which has now been defended by, among others, the Dutch psychologist Buytendijk with arguments based on phenomenology. Exercises that required strength, courage and endurance, and competitions continued to be considered unfeminine and dangerous to health. These stereotypical ideas about femininity and sport had various consequences: they determined, for example, the curricula of gymnastics classes in sport clubs, which were considered to be boring and therefore not popular with many female students. Other consequences were the exclusion of women in many sports, such as soccer, although there were already professional female soccer teams in Germany like 1 FC Nuremberg or Hamburger SV (Pfister, 2012). In the 1950s, only about 10% of sports club members were female.

The lack of workers as a result of the economic upswing of the 1960s fundamentally changed goals and strategies in women's and family policy. Women were labor market reserves and were now mobilized through targeted advertising. In addition, decisive impulses in the struggle for equal rights for both sexes came from the New Women's Movement, which had developed in the late 1960s in the context of the 'student movement' in the United States.

It made a crucial contribution to improving the situation of women, above all through information, education and action. In the last decades the number of women participating in sports continued to increase in Germany and the western

industrialized countries and female athletes can now compete in all disciplines. However, there is still a gender gap in terms of earning potential, power and influence in sports, which has to be overcome with targeted measures by women and men (Pfister, 2017). The history of modern sport is a history of gender images. From the very beginning, completely different functions were attributed to sport, depending on whether women or men played it. Many sports still struggle to emancipate themselves from the bourgeois ideals of masculinity and femininity according to which sport was shaped in the 19th century.

1.2.2 Foundations of Sex/gender Socialization

These sex/gender differences continue to drag into the education of children today. Gender-specific character attributions are ubiquitous from birth. How cute is the girl or how strong is the boy, is what children in many cultures hear, learn and grow up with (Biskup & Pfister, 1999). In early childhood, girls and boys are taught what it means to be a girl or a boy. Accordingly, in an effort to behave *correctly*, children adopt the characteristics assigned to their own gender (Biskup & Pfister, 1999). Furthermore, it is remarkable that girls are less likely to be dismissed for "boyish" play behavior, while parents generally disapprove of "girly" behavior - such as playing with dolls - of boys (Firley-Lorenz, 2004). This socialization process is reinforced by names, hairstyles, clothing and jewelry, which contribute to the child's gender-typical labeling (Faulstich-Wieland, 2008). This upbringing in role models leads to the increased training of certain skills depending on sex/gender. With regard to the development of movement, body and sports in boys and girls, gender-differentiated environmental influences shape them in particular. Stereotypical images of the abilities and skills of both sexes are also found with

regard to physical and sporting activities. In the socialization process, gender-typical rules and norms for dealing with the body, movement and sport are derived from these and have a decisive influence on the upbringing of adolescents. This often results in different experiences of space and movement for the genders. In this respect, many parents allow boys greater exploration space than the better protected girls, who are brought up to conform and empathize. Male adolescents are given more toys, which, among other factors, encourage them to increase their motor activity. They are also often rewarded more for their sporting achievements (Hoven, 2017).

Hunger explains these gender-specific behavior patterns by the fact that even kindergartens do not provide physical education within a gender-neutral framework, but are characterised by gender-typical behavior patterns (Hunger, 2007). Shutts et al. (2017) stated that gender-neutralizing practices may reduce children's sex/gender stereotyping. As far as role behavior is concerned, there are gender-specific disadvantages or advantages for boys and girls just as there are in other educational institutions. According to Hunger, it is not so much the stereotypical role concepts of the environment but rather the unconscious moments of behavior of the reference persons and the total of inconspicuous socialisation instances (toys, sports equipment, media, etc.) as well as the increasing interpretation of one's own gender role by the child itself that achieve corresponding socialisation effects in body and movement socialisation (Hunger, 2007). In this time, boys are socialized through their environment in a more movement-intensive way, supported in their material and space exploring activities, introduced to competition-oriented games as well as performance and function-

related physical activities. They can identify with public sports idols at an early stage and emulate them in the form of participatory fantasies, insofar as the corresponding male role models are present with increasing media consumption.

The affirmations and unequal treatment, reinforced in childhood, are related to career choice, career opportunities and income, and further to differences in gender representation in influential positions, e.g. in politics as well as the PA behavior (Heisig, 2019).

1.3 Efficacy of Interventions to Promote PA in girls and boys

The differences in PA in between girls and boys are given and many interventions try to promote PA in youth. Furthermore, it seems that these interventions are less successful for girls than for boys (Biddle et al., 2014). However, a meta-analysis conducted by Pearson et al. (2015) shows, that interventions in adolescent girls show small but significant effects in increasing PA. Another meta-analysis by Love et al. (2019) examined 14 school-based interventions promoting PA in adolescents with accelerometer-assessed data. They also could not identify any significant effects in boys and girls and significant differences in between the both. In contrast, Jones et al. (2020) found a small, significant effect in daily PA in their mixed-studies. Metcalf et al. (2012) analyzed 26 studies which included both girls and boys of which only four sex/gender specific results report.

In the umbrella review of van Sluijs et al. (2021) the special role of school based interventions was pointed out. The authors stated, that PA should be promoted in sports during school time as well as activity in specific school areas. A recommendation of how to integrate sex/gender in these interventions has not

been made. Woodforde et al. (2021) examined ten school-based PA programs studies in 13 reports in a systematic review regarding the effects on PA, learning related outcomes and health. They did not provide any sex/gender specific results in their systematic review, but discussed that programs, underpinned by theory, may be more effective than programs without any theoretical background (Owen et al., 2017).

In summary, the evidence regarding PA and gender is highly inconsistent and more research is needed on the specific area of sex/gender. The sex/gender gap in PA is obvious. Nevertheless, this has not been sufficiently taken into account in research to date. As a result, previous interventions cannot make a valid statement about whether and how the intervention has worked for boys and girls. As discussed in the previous chapters, there are different behaviors that may require different interventions, and common behavioral interventions may not change them sufficiently.

1.4 Critique of Current Research

Despite the differences between boys and girls in PA, which have been known for a long time, the causes have not yet been identified (Courtenay, 2000; Johnson & Repta, 2012; Saltonstall, 1993). Interventions that attempt to minimize these differences also have limited success (Love et al., 2019). Furthermore, many interventions pay insufficient attention to the problem of the sex/gender gap (Love et al., 2017; Mears & Jago, 2016; Schulze et al., 2020; Watson et al., 2017). To make intervention studies more gender-sensitive, a tool is needed to assess this problem.

One guidance document was developed of the Sex/Gender Methods Group, part of the Campbell and Cochrane Equity Methods Group. This tool was developed for assessing the influence of gender/sex on intervention effectiveness in systematic reviews on HIV hypertension and musculoskeletal health (Doull et al., 2014). Another tool is the PROGRESS-Plus Acronym. This describes several socio-demographic factors (e.g., race/ethnicity, gender, education, socio-economic status) to be considered in systematic reviews, as they may have an impact on health (Welch et al., 2015). Attwood et al. (2016); Humphreys and Ogilvie (2013) conducted systematic reviews about PA according to PROGRESS-Plus items. Both reviews found that gender was the most commonly studied variable related to equity and still there is no specific guideline how to consider sex/gender adequately in systematic reviews.

An extension of the PRISMA guidelines was extended for the PRISMA-E(quity) guideline in 2012 (Welch et al., 2015). This extension helps reviewers to identify, extract, and synthesize evident information on equity in systematic reviews.

Another existing checklist is the Sex and Gender Equity in Research (SAGER) guidelines (Heidari et al., 2016). These guidelines focus on the one hand on reporting of sex/gender sensitive data for authors. On the other hand, the guidelines provide editors with a flowchart on which points they can relate to when reviewing of sex/gender when reviewing submitted articles (Heidari et al., 2016). These guidelines give authors a good indication of how to consider sex/gender, but it is important to note that the specific items are only given a very general consideration.

In summary, it can be stated that currently there is no tool to systematically assess sex/gender considerations of intervention studies promoting PA and/or reducing SB in systematic reviews. Moreover, no systematic review exists, which systematically addresses sex/gender in the planning, implementing and evaluating of interventions promoting PA and/or reducing SB.

2 Aims of the Studies

Sex/gender differences in PA in children and adolescents are obvious, while girls are less physically active than boys (Guthold et al., 2020). To reduce this problem, interventions are being implemented to increase PA and decrease SB in youth. However, it is very difficult to adequately account for sex/gender discrepancies.

In this thesis, the first sex/gender checklist for intervention studies promoting PA and/or reducing SB is established. This checklist is a special tool with two fields of application. First, to assess the sex/gender consideration of intervention studies in systematic reviews in this field of research. Second, it can be applied when developing a new intervention study as a guide to adequately consider sex/gender in all stages of an in all stages of the planning, implementation and evaluation of an intervention.

In publication 1 the aim was to assess sex/gender considerations in 217 intervention studies promoting PA and reducing sedentary behavior (SB) in youth using the newly developed a sex/gender checklist. In publication 2, there was a special focus on the school-based intervention. Schools are an important setting for the promotion of PA, because in schools all children can be reached regardless of age, gender or social background (Aubert et al., 2018; Hills et al., 2015). At school, the promotion of PA can be carried out in different areas. It starts with the way to school, goes on in the classroom, during breaks, in physical education classes, and in the after-school time (World Health Organization, 2018). Furthermore, the interventions in schools influence the health and well-being of

students (Singh et al., 2019; van de Kop et al., 2019; Vaquero-Solis et al., 2020; Yuksel et al., 2020).

The effects of the interventions on PA were evaluated in a narrative synthesis and the extent of considering sex/gender in the developing, implementing and evaluating of interventions promoting PA were explored. In a further step, meta-analyses were conducted to compare the intervention effects on PA of girls and boys.

3 Methodology

The following studies resulted from the work conducted in the genEffects project. Funded by the Federal Ministry for Education and Research (BMBF), the project genEffects analyzes the efficiency of measures attempting to increase PA and decrease SB with a special focus on sex/gender. The project lasted for two and a half years (January 2018 until June 2020). Partners were the University of Education, Heidelberg, Chemnitz University of Technology (from 15/05/2019 Friedrich-Alexander University of Erlangen-Nuremberg) as well as the Cochrane Sex/Gender Methods Group.

In a first step of the project, we developed a checklist to systematically analyze the degree to which intervention studies take sex/gender into account. With the support of both national and international experts the sex/gender checklist was created in an iterative process. The second phase of the project consisted of the creation of systematic reviews. For this, intervention studies aiming to either increase PA or decrease SB amongst children and adolescents were included. The third part of the project is to take the new insights into practice. The theoretical results are analyzed with stakeholders in workshops and recommendations for an evidence-based transfer into practice are worked out and disseminated afterwards.

3.1 Publication 1

In order to assess the degree to which sex/gender was considered in intervention studies that promote PA and/or reduce SB in participants, a comprehensive sex/gender checklist in a three-step procedure was developed. First, the existing literature (De Castro et al., 2016; Jahn et al., 2017; Johnson et al.,

2009; Pederson et al., 2014; Welch et al., 2013) and tools (Doull et al., 2011; Doull et al., 2010; European Commission, 2009; Jahn, 2005; Nieuwenhoven & Klinge, 2007) that appraise sex/gender in research were collated, including existing guidance for systematic review authors (Doull et al., 2011; Welch, 2014). Second, the existing instruments were summarized and checked for applicability to the objectives, sex/gender consideration in interventions promoting PA and/or reducing SB. Third, the first draft of the sex/gender checklist was set up and finalized in collaboration with international experts in the field of sex/gender sciences and methodology (e.g., members of the Cochrane Sex/Gender Methods Group, a subgroup of the Campbell and Cochrane Equity Methods Group). The final version of the sex/gender checklist consists of ten items in the following categories: background and concepts, study design, intervention planning and delivery, presentation and interpretation of findings. These items are rated using three categories by item-specific definitions and provide information on the extent to which the primary study took sex/gender into account regarding the respective item.

Furthermore, the systematic literature review aimed to identify intervention programs promoting PA and/or reducing SB in healthy children and/or adolescents within the average age range of three to 19 years conducted from January 2000 to August 2018 and published in peer reviewed journal articles. The literature review was conducted according PRISMA guidelines for a systematic analyses of the current state of research (Moher et al., 2015). The intervention aim must be the promotion of PA and/or reduction of SB by any type of quantified measure in a controlled intervention study. The control group was not allowed to receive PA or

SB intervention. PA and/or SB in all domains may be assessed by any type of measure (subjective/objective). Descriptive or inferential statistical outcomes of PA and SB must be reported for sex/gender disaggregated at baseline and/or follow-up and displayed in text and/or tables and/or for sex/gender disaggregated in relation from baseline to follow-up and displayed in text and/or tables and/or that there were no differences in the outcome when looking at sex/gender and no further analyses were carried out and/or how they dealt with sex gender in measuring the outcomes (e.g., adjustment). Two researchers performed the study selection process independently using Covidence software (Veritas Health Innovation, 2018). All discrepancies were solved by a third researcher. After the removal of duplicates, titles and abstracts were screened, and all potentially relevant articles, along with those of undetermined relevance, were subsequently retrieved and screened against the eligibility criteria.

3.2 Publication 2

The second study aimed both to evaluate the effects of interventions to promote PA among girls and boys in the school context and to assess the extent to which these intervention studies took sex/gender into account in their design, implementation, and evaluation phases. As an extension to Study 1, the literature search was amended to select only interventions in the school setting. Additionally, meta-analyses to compare the intervention effects between girls and boys were conducted.

The sex/gender assessment was performed as in study 1. The risk of bias assessment was conducted for each study by two independent researcher using the Cochrane risk of bias tool (Higgins et al., 2011; Higgins & Green, 2011). The

meta-analyses were conducted to determine the effect of school-based interventions to promote PA in children and adolescents for girls and boys separately using Comprehensive Meta-Analysis software (Biostat Inc., 2020). The meta-analytical effect size estimates were based on baseline and post-interventions means, standard deviations and the sample size. When data was available in other formats, data transformation was applied (Higgins & Green, 2011). Hedges' g was then calculated by dividing the between-group difference of mean change from baseline by the pooled SD of change for the groups, assuming a correlation of $r = 0.5$ between baseline and postintervention (Higgins & Green, 2011; Morris, 2007). In cases of multiple reported outcomes for PA within one comparison, data was extracted and combined to form one pooled effect size (Borenstein et al., 2009).

To analyze the differences and similarities between girls' and boys' PA in the interventions, based on their effectiveness with both sexes. Differences and similarities are reflected in the qualitative ratings obtained on the sex/gender checklist. In this analysis, we divided the studies into three superordinate groups. The first group consisted of studies with intervention effects in the same direction for girls and boys; this group was then subdivided into those with significant positive effects for girls and boys, those with significant negative effects for either sex/gender. Second, studies with different intervention effects for girls and boys were divided into four subgroups: positive significant effect for boys and no effect for girls, positive effect for girls and no effect for boys, negative effect for girls and no effect for boys, and negative effect for boys and no effect for girls. Third, among studies involving subjects of a single sex, we distinguished those that were

effective from those that were not. In all three above-mentioned groups, the number of ratings of “detailed”, “basic”, “no information provided”, “poor”, and “not relevant” on every item of the checklist was calculated. Using these analyses, we were able to identify those with no intervention effect for girls and boys and for both genders.

4 Publications

4.1 Publication 1

Authors: Annegret Schlund, Anne K. Reimers, Jens Bucksch, Catherina Brindley, Carolin Schulze, Lorri Puil, Stephanie E. Coen, Susan P. Phillips, Guido Knapp, and Yolanda Demetriou

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Journal: Journal of Physical Activity and Health

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Summary:

Physical inactivity is often reported in youth and differs among boys and girls. The aim of this study is to assess sex/gender considerations in intervention studies promoting PA and reducing SB in youth using a sex/gender checklist.

A systematic search was conducted in August 2018 to identify all relevant controlled trials. Studies screened must have reported a quantified measure of PA and/or SB, and identified participants by sex/gender at baseline. For evaluation of the sex/gender consideration we used a sex/gender checklist developed by expert consensus.

We reviewed sex/gender considerations in all aspects of intervention development, implementation and evaluation in 217 studies. Sex/gender aspects were only rudimentarily taken into account, most frequently during statistical analyses such as stratification or interaction analysis.

Sex/gender effects are not sufficiently reported. To develop guidelines that are more inclusive of all girls and boys, future interventions need to document sex/gender differences and similarities, and explore whether sex/gender influences

different phases of intervention programs. The newly developed sex/gender checklist can hereby be used as a tool and guidance to adequately consider sex/gender in the several steps of intervention planning, implementation and evaluation.

The manuscript was submitted in the *Journal of Physical Activity and Health*, which is an interdisciplinary, peer-reviewed, journal, in October 2020, accepted in January 2021, and published in April 2021.

Contribution:

Annegret Schlund prepared the first draft of the manuscript. All authors were involved in a priori protocol development including the development of the sex/gender-checklist, and the search strategy. Annegret Schlund, Catharina Brindley, Carolin Schulze performed the searches, with search strategies devised in consultation with Douglas M. Salzwedel, information specialist with Cochrane Hypertension, University of British Columbia, Canada, and Lorri Puil. Annegret Schlund, Catharina Brindley, Carolin Schulze conducted the screening of the search, extracted the data, appraised the study quality and conducted the grading with the sex/gender-checklist. Anne K. Reimers, Jens Bucksch and Yolanda Demetriou supervised this process. All authors contributed to the interpretation of the results, critically reviewed the manuscript and approved the final manuscript. Anne K. Reimers, Jens Bucksch and Yolanda Demetriou secured the funding for the study and conceived the genEffects project.

Do Intervention Studies to Promote Physical Activity and Reduce Sedentary Behavior in Children and Adolescents Take Sex/Gender Into Account? A Systematic Review

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Background: Physical inactivity is often reported in youth and differs among boys and girls. The aim of this study is to assess sex/gender considerations in intervention studies promoting physical activity and reducing sedentary behavior in youth using a sex/gender checklist. **Methods:** A systematic search was conducted in August 2018 to identify all relevant controlled trials. Studies screened must have reported a quantified measure of physical activity and/or sedentary behavior, and identified participants by sex/gender at baseline. For evaluation of the sex/gender consideration, the authors used a sex/gender checklist developed by expert consensus. **Results:** The authors reviewed sex/gender considerations in all aspects of intervention development, implementation, and evaluation in 217 studies. Sex/gender aspects were only rudimentarily taken into account, most frequently during statistical analyses, such as stratification or interaction analysis. **Conclusions:** Sex/gender effects are not sufficiently reported. To develop guidelines that are more inclusive of all girls and boys, future interventions need to document sex/gender differences and similarities, and explore whether sex/gender influences different phases of intervention programs. The newly developed sex/gender checklist can hereby be used as a tool and guidance to adequately consider sex/gender in the several steps of intervention planning, implementation, and evaluation.

Keywords: checklist, girls, boys, youth, equity

A large body of evidence is available showing that physical activity (PA) in children and adolescents is positively associated, and sedentary behavior (SB) negatively associated, with physical, social, psychological, and emotional health.^{1,2} Nevertheless, children are insufficiently active and differences in PA and SB between girls and boys exist. As the foundation for an active lifestyle is developed in childhood and adolescence and tracks into adulthood, children and adolescents are high priority target groups for PA promotion and SB reduction.^{3,4}

There is a strong tradition of gender and health research that conceptualizes health behaviors (such as PA and SB) as both shaped by and as expressions of societal constructions of gender (eg, masculinity, femininity).⁵⁻⁷ Increasingly, theoretical approaches to gender and health acknowledge that sex-based biological factors and gendered social factors are entangled in the sense that it is not always possible to theoretically or empirically isolate

the influences of the biological and the social.⁸ In recognition of this complexity, in this article we use the term sex/gender.⁹

A systematic review by Mears and Jago¹⁰ on the effectiveness of after-school programs to enhance moderate to vigorous physical activity in children and adolescents, reported that a small minority of studies had conducted subgroup analyses in boys and girls with some evidence of greater effects on moderate to vigorous physical activity in boys but too few studies to draw conclusions. They also highlight that very few studies focused on exploring sex/gender differences or similarities and the underlying causes or mechanisms of any observed differential effects.¹⁰

Tools such as the Equity Extension of the Preferred Reporting Items in Systematic Reviews and Meta-analysis (PRISMA-E) or PROGRESS-plus can aid researchers in considering sex/gender in systematic reviews. PRISMA-E specifies items to report that are essential to understanding issues of equity and fairness. The PROGRESS-plus acronym identifies gender and other sociodemographic factors (eg, race/ethnicity, education, and socioeconomic status) that may impact health equity and potentially intersect with gender.^{11,12} However, because both these tools are comprehensive in their treatment of equity-related issues, neither focus on sex/gender consideration in depth and there is no specific tool to analyze sex/gender in PA or SB primary studies.

Two PA reviews analyzed equity issues according to PROGRESS-Plus items but only in adult populations.^{13,14} Both reviews concluded that sex/gender was the most often studied variable regarding equity in reviews as well as in primary studies. A majority of the intervention studies reported that baseline characteristics differed between men and women and different interventions had different effects on men and woman. Some of the studies had a bigger impact on women and some on men.¹⁴ It was

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suggested that features, such as intervention content, setting as well as outcome measures, might have been responsible for differential findings by sex/gender.¹³ However, the authors did not delve further into these findings and the findings were inconsistent, so this does not allow one to draw conclusions that there are significant differential effects.

To examine possible sex/gender differences and to minimize any potential sex/gender-related inequities, a tool for assessment and consideration of sex/gender in all stages of the design, implementation, and evaluation of an intervention, as well as for the conduct of systematic reviews, is required. This includes identifying if and how intervention studies take sex/gender into account when formulating research questions and in any underpinning theories, in study design, sample recruitment, and measurement instruments, and in all aspects of the reporting of sex/gender-related data.^{15–17} Therefore, the aim of this study was to evaluate sex/gender considerations in a comprehensive way in intervention studies aimed at promoting PA and/or reducing SB in children and adolescents.

Evidence Acquisition

This systematic review is reported according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (see [Supplementary Material 1](#) [available online]). The protocol for the review was published previously and also registered with PROSPERO (ref CRD 42018109528).¹⁸ There were no substantial changes to the protocol. As part of a systematic review, termed the genEffects project, we examined the sex/gender considerations of all included studies.¹⁸ The genEffects project had 2 goals: to determine whether PA and SB interventions targeting children and adolescents had similar or differential effects on boys and girls, and to determine how studies took sex/gender into account; the latter findings are the focus of this paper.¹⁸ Effectiveness results will be reported in separate papers. We searched 11 electronic databases from January 2000 to August 2018 and with a search strategy based on Cochrane standards (see [Supplementary Material 2](#) [available online]).

Two researchers performed the study selection process independently using Covidence software (Veritas Health Innovation, Melbourne, Australia; www.covidence.org) and followed the inclusion criteria (Table 1). All discrepancies were resolved by a third, senior researcher. After removal of duplicates, titles and abstracts were screened and any potentially relevant article or those of indeterminate relevance were subsequently retrieved and screened against eligibility criteria.

For each included intervention study, specific details were extracted by 2 reviewers independently, using a piloted data extraction form to ensure consistency. Data extraction covered information about general study characteristics, sample size for intervention and control groups stratified by sex/gender and drop-out rate, details about intervention content as well as intervention approaches, and settings. For additional information, study protocols and supplementary material were used and in the case of missing information, authors were contacted (maximum of 2 contact attempts).

To evaluate the degree to which sex/gender was considered in the included intervention studies, we developed a comprehensive sex/gender checklist in a 3-step procedure. First, the existing literature and tools that appraise sex/gender in health research were collated, including guidelines for systematic review authors.^{19–30} Second, we summarized existing instruments and checked them for applicability to our objectives. Third, a draft sex/gender checklist was developed in collaboration with 16 international multidisciplinary researchers with expertise in the field of sex/gender methodology (eg, members of the Cochrane Sex/Gender Methods Group, a subgroup of the Campbell and Cochrane Equity Methods Group). The final sex/gender checklist consists of 10 items (see [Supplementary Material 3](#) [available online]). The items were rated using 5 classifications, guided by item-specific definitions, to determine the extent to which the primary study took sex/gender into account for each item. The main ratings are categorized broadly as *detailed*, *basic*, or *no information provided*. Studies are rated with *detailed* when they considered sex/gender in the specific item in a comprehensive and extensive way (for item-specific description of the detailed classification see [Supplementary Material 3](#) [available online]). *Basic* is rated when studies mentioned sex/gender in context of the specific item and did not elaborate the topic further (for item-specific description of the basic classification see [Supplementary Material 3](#) [available online]). *No information* is rated when studies did not provide any information about sex/gender in context of the respective item. For studies that recruited only boys or girls, a fourth classification, *not relevant*, was used for items that were considered less applicable to single sex/gender studies, for example, provision of sex/gender-disaggregated data for participant flow (items 4, 5, 8, and 9). Some single sex/gender studies have nevertheless provided additional information, which we then rated as basic or detailed. For the first item only (*definition and use of sex and/or gender terminology*), *poor* was also a rating for those studies that used the terms sex and gender interchangeably. Two

Table 1 Eligibility Criteria for the genEffects Systematic Review

Category	Included
Population	Healthy children and/or adolescents within the average age range of 3–19 y
Intervention	Aim of the intervention must be the promotion of PA and/or reduction of SB by any type of quantified measure
Study design	Controlled intervention studies
Control group	No PA or SB intervention
Outcomes	PA and/or SB in all domains assessed by any type of measure (subjective/objective) Descriptive or inferential statistical outcomes of PA/SB must be reported <ul style="list-style-type: none"> • for sex/gender disaggregated at baseline and/or follow-up and displayed in text and/or tables and/or • for sex/gender disaggregated in relation from baseline to follow-up and displayed in text and/or tables and/or • that there were no differences in the outcome when looking at sex/gender and no further analyses were carried out and/or • how they dealt with sex/gender in measuring the outcomes (eg, adjustment)
Publication type	Peer-reviewed journal articles published after year 2000 in English

Abbreviations: PA, physical activity; SB, sedentary behavior.

researchers independently assessed studies for the 10 items of the sex/gender checklist. When multiple publications reported the same trial, the trial was assessed only once, using all available information.

Evidence Synthesis

The search identified 24,835 records after removing duplicates (see Figure 1). During the review of titles and abstracts, 683 articles were included for detailed assessment via full-text screening. A total of 217 unique studies (in 244 articles) met eligibility criteria (see [Supplementary Material 4](#) [available online]). Sixteen studies had more than one identified publication.

The identified studies measured different outcomes regarding PA and SB, which we divided in the following subgroups: overall PA ($n = 97$), PA in school ($n = 62$), leisure-time PA ($n = 31$), active commuting ($n = 12$), and SB ($n = 71$). We sorted all study results that did not fit in these groups in a third category “other outcomes” (eg, physical fitness or nutrition; $n = 28$). The most frequently used measurement instruments were accelerometers ($n = 173$) and/or questionnaires ($n = 113$).

In the primary studies, the methods for addressing sex/gender varied. A single sex/gender sample was included in 34 studies. Sixty-seven studies reported results disaggregated by sex/gender. Thirty studies investigated whether a significant interaction existed between group, sex/gender, and time. Thirty-seven studies examined whether differences existed between boys and girls, but quantitative results were not displayed. Finally, 76 studies adjusted for sex/gender.

The sex/gender checklist rating procedure was carried out for all included 244 articles. When multiple publications reported the same trial, they were included only one time resulting in 217 evaluations per item. The highest rating across all publications provided was achieved. In total, 159 conflicts were resolved during our application of the sex/gender checklist through discussion among 2 independent reviewers. These represent 7.3% out of all rated items.

The results of the checklist show that with regard to the background, planning, and implementation of the intervention (items 3–7 of the checklist), no information was provided in the majority of the studies. Primary studies increasingly dealt with sex/gender in the “Results” section. Forty-one studies (19%) reported

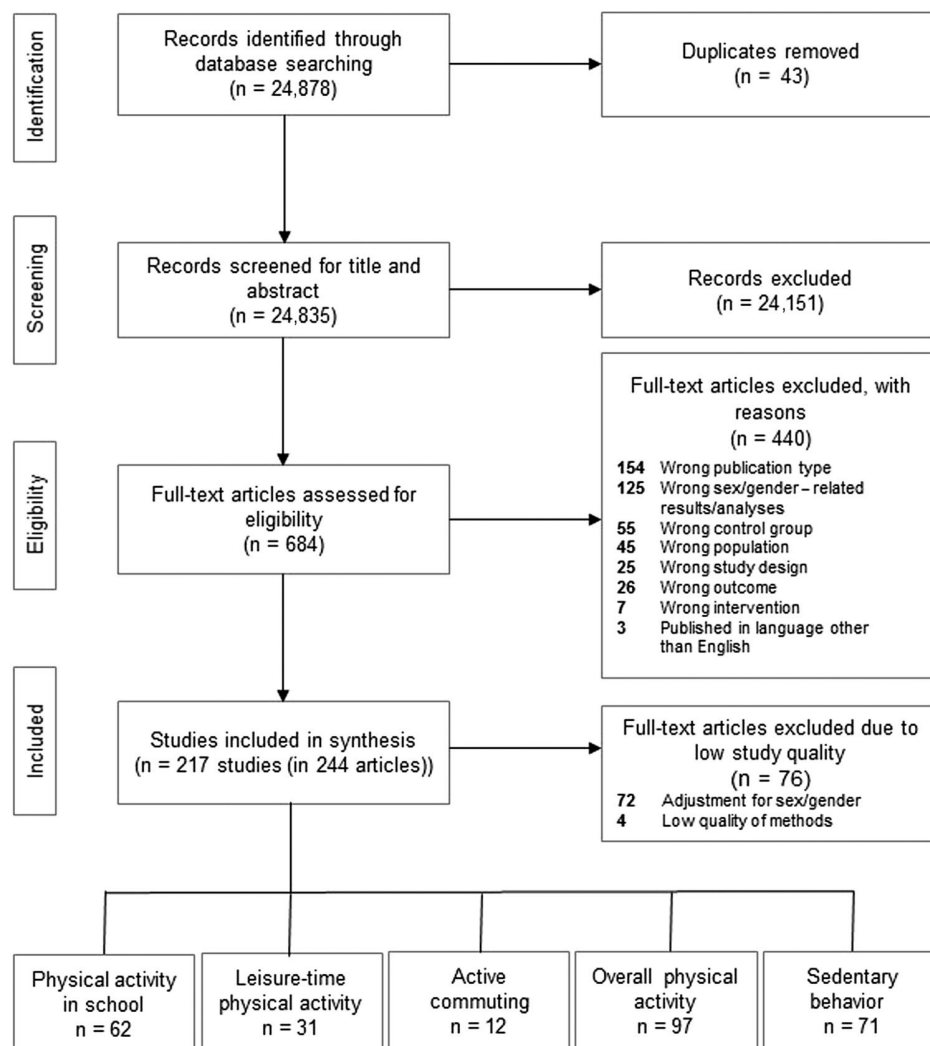


Figure 1 — Preferred Reporting Items in Systematic Reviews and Meta-analysis flowchart.

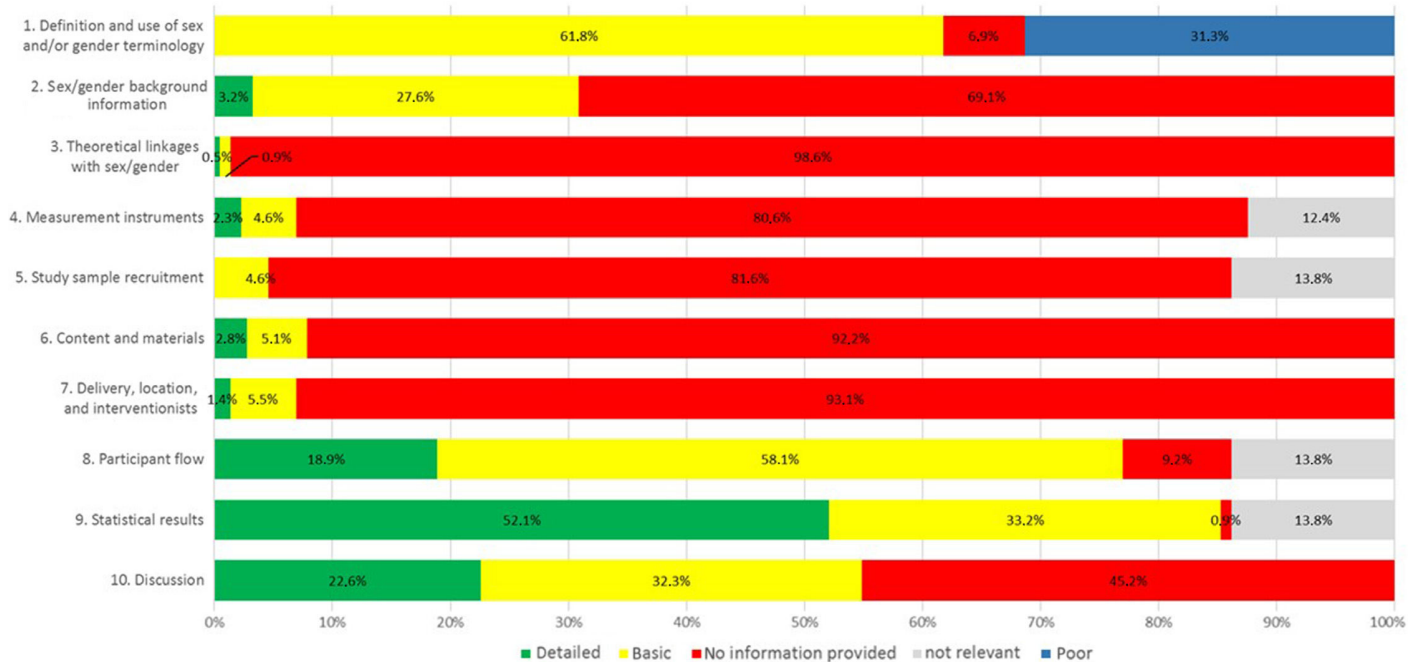


Figure 2 — Summary of the results of the sex/gender checklist.

the number of girls and boys in intervention and control groups at all measurement points. In the results, 113 studies (52%) reported sex/gender, that they were rated *detailed* for and 49 studies (23%) discussed their findings with regard to sex/gender. The rating of each individual study for each item is presented in [Supplementary Material 5](#) (available online). The highest rating on the sex/gender checklist was a study that was rated *detailed* on 6 different items.³¹ Three studies (1%) were rated *detailed* on 4 different items.^{32–34} In contrast, 77 studies (35%) had no *detailed* ratings. There was no study that reported information across all 10 checklist items. Ten studies (4.6%) were rated *no information provided* on 8 different items.

The first item of the sex/gender checklist describes whether the use of sex and/or gender terminology was defined in the study. Of the 217 studies, none defined and used consistently one of the terms “sex,” “gender,” or “sex/gender” which was required for a rating of *detailed* for this item (see Figure 2). In 134 studies (62%), “sex” or “gender” was used consistently and not interchangeably, with 66 studies using the term “sex” and 68 using the term “gender.” These studies were rated as *basic* for item 1. Sixty-eight (31%) of the studies used the terms “sex” and “gender” interchangeably without any explanation, earning the rating “poor.” Fifteen (7%) of the studies provided no information about sex/gender terminology.

The second item examines whether sex/gender background information was identified as a consideration when formulating the research question. Contextual information regarding sex/gender differences and/or similarities was provided in the background and introduction of only 7 studies (3%) that were, therefore, categorized as *detailed*. For example, Taymoori et al³⁵ described the cultural difficulties for Iranian girls in meeting recommendations for PA. In 60 studies (28%), sex/gender background was considered at a *basic* level, meaning that these studies only mentioned sex/gender considerations regarding the research questions. In total, 150 studies (69%) did not provide any sex/gender background information on the research question.

The last item within *background and concepts* considered *theoretical and/or conceptual linkages with sex/gender* (item 3). This relates to whether studies used an underlying behavioral theory in relation to sex/gender. One study (0.5%), by Sigmund et al³¹ did this in a *detailed* fashion by considering the theory of coeducation in terms of sex/gender by coeducating boys and girls in the same school, in the same class.³¹ Taymoori et al³⁵ and Rosenkranz et al³⁶ included conceptual linkages of connecting the intervention with sex/gender and were rated as *basic*, so Rosenkranz et al³⁶ conducted their intervention in collaboration with the Girl Scout nonprofit organization, which is devoted to building the courage, confidence, and character of girls. The vast majority of studies (99%) did not provide any information regarding theoretical and/or conceptual linkages with sex/gender.

The item *Measurement instruments* (item 4) evaluates the degree to which the measurement instruments are tested to be valid and reliable for girls and boys. As, for example, boys tend to be more active in vigorous PA and pedometers underestimate vigorous PA, pedometers tend to underestimate PA of boys.³⁷ Therefore, to avoid measurement instruments measuring PA differently for boys and girls, the measurement instrument should be tested valid and reliable for sex/gender. Five intervention studies (2.3%) by Babic et al,³⁸ Pate et al,³⁹ Sigmund et al,³¹ Story et al,⁴⁰ and Young et al⁴¹ reported validated measurement instruments for sex/gender groups. In 10 studies (5%), this item was rated *basic* because measurement instruments used are not developed for sex/gender groups (reliable or valid), but reasons for this decision are given. In 27 (12%) studies as *not relevant*, because of single sex/gender studies. In addition, 175 (81%) of the interventions did not provide any information about the measurement instrument concerning sex/gender.

In item *study sample recruitment* (item 5), we examined how study investigators took sex/gender into account in sampling. Thirty studies (14%) recruited only one sex/gender group (boys or girls) so this particular item was rated as *not relevant*; although,

we acknowledge study investigators may have been prompted to enroll only one sex/gender group for sex/gender considerations. No study reported on inclusion of gender-diverse participants. Of the 187 mixed-sex/gender studies, no study included a power calculation with respect to sex/gender and was rated as *detailed*. The 10 studies (5%) that described how sex/gender was taken into account during sampling were rated as *basic*. For example, in the UP4FUN research, in which teachers were equipped with materials about, for example, PA, SB, and activity breaks, “schools were paired according to size, gender and socio-economic status.”⁴² None of the remaining 177 (82%) studies reported information about sex/gender considerations in sampling.

The third category of the sex/gender checklist was *intervention planning and delivery*. This comprises 2 items (items 6 and 7), *intervention content and materials* (eg, brochures, leaflets, plans of sessions) and *intervention delivery, location, and interventionists*. Six (3%) studies described content/materials in terms of sex/gender. For example, the “Dads And Daughters Exercising and Empowered” program by Morgan et al⁴³ had a primary focus on education, “redefining gender norms, developing the girls’ critical thinking skills, and eliciting meaningful support from their fathers as gender equity advocates.” Girls were taught to resist, question, and negotiate real-world PA barriers in empowering ways. Another 11 (5%) studies described the intervention content/materials in terms of sex/gender inclusiveness, but did not report on implementation. For the remaining 200 (92%) studies, no information was provided on whether the intervention content/materials were considering sex/gender.

Item 7 (intervention delivery, location, and interventionists) rated whether the intervention was sex/gender inclusive regardless of the mode of intervention delivery, location, and the person(s) carrying out the intervention and 3 (1%) studies were rated *detailed*. Sigmund et al³¹ gave sex/gender attention by offering specific programs for girls and boys. In addition, PA with boys and girls together was fostered by the teachers. Twelve (6%) studies in which the importance of a sex/gender-inclusive intervention delivery, location, or person carrying out the intervention was mentioned were rated *basic*. For example, Cui et al⁴⁴ intentionally sex/gender-balanced the 8 peer leaders, who conducted parts of the intervention but no further explanations regarding this procedure were given. *No information was provided* about sex/gender-inclusive modes of intervention delivery, location, or the person carrying out the intervention in 202 (93%) studies.

Item 8 (participant flow) of the sex/gender checklist assessed whether participant flow provides information about sex/gender as part of trial participant accounting.⁴⁵ At all measurement points, 41 (19%) studies provided the sample size for boys and girls and were therefore rated *detailed*. A *basic* rating was given to the 126 (58%) that provided sample size for girls and boys separately at least once while in 20 studies (9%), no information about the sex/gender of participants was provided for any measurement. In the 34 (14%) studies that enrolled a single sex/gender group, this item was rated as *not relevant*.

Statistical results (item 9) was the second item of the category Presentation of findings and evaluated whether differences and/or similarities for sex/gender were described in the outcomes of the studies. This item was addressed in *detail* by 113 (52%) studies because they included sex/gender statistics on main outcomes and looked for possible sex/gender differences and/or similarities in intervention effects (using, eg, sex/gender-disaggregated analyses, stratified analyses, interactions). Another 72 studies (33%) reported statistical analyses for sex/gender differences and/or similarities

regarding the main outcomes but did not report the effect sizes for sex/gender. In 2 studies (1%) there was *no information provided*. In 30 studies (14%), this item was rated as *not relevant*.

The last category *interpretation of findings* consists of only one item *Discussion (item 10)*. Rated as *detailed* were 49 (23%) studies because study investigators reflected on their findings and future directions with respect to sex/gender. Dudley et al⁴⁶ also describe the importance of adapting environmental conditions to facilitate girls’ PA and to enable making self-effective decisions. In the intervention study of Parrish et al.⁴⁷ it was observed that the PA behavior in recess differs between boys and girls, with girls spending more time in sedentary time and boys being active in ball play at baseline. The intervention worked better for girls than boys. They discussed if their introduced portable equipment (eg, ropes or hoops) may change the behavior of girls in more active behavior. Seventy (32%) studies were rated *basic*, as sex/gender findings were discussed without any consideration of future directions. Ninety-eight (45%) studies did not provide any information on this subject.

Discussion

This review approach assessed the sex/gender considerations made in all steps of an intervention development, implementation, and evaluation in 217 intervention studies aiming to promote PA and/or reduce SB in children and adolescents. Overall, sex/gender aspects were only rudimentarily considered in the included primary studies. Our eligibility criteria required that trials report, as a minimum, sex/gender-disaggregated characteristics at baseline, which resulted in exclusion of 125 studies.

Only during the statistical analyses of the intervention effects was sex/gender likely to be addressed in more detail. Even this finding is a result of our exclusion of studies that did not report at a minimum, disaggregated findings for boys and girls for at least one timepoint. In addition, in the discussion sections of the included studies, sex/gender was often considered. These findings lead us to conclude that researchers are more likely to take sex/gender into account in analyses of intervention effectiveness and discussions instead of considering sex/gender-related aspects during all steps of intervention study.

Also to find out what kind of samples (mixed sex/gender or single sex/gender studies) are more effective for boys and girls, we need more information on how sex/gender was taken into account during sampling. In relation to the intervention content and materials, we need evidence of whether it is more effective to use different materials (eg, brochures, leaflets, plans of sessions) for girls and boys or whether the same materials should be used for all. It is also essential to report intervention delivery, location, and personnel and consider how each might have a gendered impact. For example, if the person carrying out the intervention was trained to be sex/gender inclusive in language that could alter outcomes. The findings of the sex/gender assessment and agenda items for guiding future studies are in line with systematic reviews that include sex/gender as a discriminating variable.^{13,14} With regard to the planning and implementation of interventions, it is important to consider the extent to which sex/gender is accounted for in content, materials, training of staff, and delivery in order to draw conclusions about what works how for who. Studies and systematic reviews should also present the number of participants disaggregated by sex/gender at each time of measurement when reporting results of the interventions.

Reporting sex/gender-disaggregated data alone does not actually constitute a sex/gender-based analysis and is still very rudimentary. This is just a first step to determining whether differences or similarities exist. Even if sex/gender-disaggregated data show a difference, it is far from clear whether the issue is based exclusively on sex/gender or other social determinants of health that intersect with sex/gender. Mixed-methods studies or qualitative studies are required to explore reasons for any differential effects in addition to quantitative studies. With our approach, we are going to take a next step to objectively illuminate different aspects for the adequate consideration of gender/sex. With more researchers using the sex/gender checklist, when planning, conducting, and evaluating an intervention or systematic review, we can achieve more information about how these aspects function in primary research before deciding on best interventions to promote PA and SB equitably.

The sex/gender checklist used in this systematic review approach could be a helpful tool for researchers to address sex/gender in intervention studies. Sex/gender considerations in individual studies should be part of systematic reviews. For this purpose, the sex/gender checklist developed in this project could be used. In addition, the effectiveness of interventions must be examined regarding key sex/gender elements during the entire process from theory underlying research to intervention design, implementation, and evaluation. The key strength of this systematic review approach is our innovative method for considering sex/gender using a novel sex/gender checklist. The checklist could help researchers focus on new ways of planning, conducting, and evaluating future intervention studies to adequately integrate sex/gender in other areas of health. Furthermore, our comprehensive literature search and screening based on standards for systematic reviews can be counted among the strengths of this study. The strengths of the sex/gender checklist lie in the comprehensive evaluation of sex/gender in intervention studies from intervention planning, development, implementation, and delivery to evaluation. The primary purpose of the sex/gender checklist was for appraisal of sex/gender in systematic reviews; nevertheless, the checklist can be used for guidance when planning, conducting, and evaluating an intervention study.

Limitations

Although we used a comprehensive search unrestricted by language, a limitation of the study is restriction of eligibility to English language articles and peer-reviewed publications. One limitation of the checklist is the fact that this was just identifying whether sex/gender was discussed, but not the quality and the extent of the discussion. Another potential limitation is that there is no meaningful summative score from it. Such a score could aid in comparing studies. However, the development of such a score is challenging and necessitates a relative weighing of included items. There is no established weighting at present. In the future, it might be useful to additionally explore how a sex/gender score might developed.

For future intervention studies, we recommend considering sex/gender in all aspects of intervention planning and implementation. It is important to consider in the first step how to use sex/gender terminology and whether to focus consciously on the biological, social, or connectedness of the 2 components. Furthermore, it is important to consider sex/gender with regard to the research question in order to keep the effects and characteristics of sex/gender in mind from the beginning. A theoretical concept that takes sex/gender into account with regard to the research question can help to adequately consider sex/gender. In addition, it

is important to select measurement instruments that are equally valid for all sex/gender as there are measurement instruments that measure differently for girls than for boys.^{37,48,49} In order to determine the effectiveness of interventions and possible differences in effectiveness with respect to sex/gender, it is important that statistical power calculations have been performed with respect to sex/gender. Only in this way can the effectiveness or non-effectiveness of interventions be attributed or denied to sex/gender. In order to find out how the content, materials, the intervention implementation, the location, and the implementing persons affect different sex/gender groups, it is important that considerations are made in advance and that the implemented intervention is precisely documented with all components. This is an important step forward to find out whether a certain place works better for girls or boys, whether girls benefit more from female or male interventionists, or whether this does not matter. Furthermore, it is important that sex/gender and the dropout rate are documented at all measurement points to determine whether sex/gender differentially affects dropouts and to find possible reasons for this. To interpret the results in relation to sex/gender, statistical analyses should also be carried out, for example, disaggregated or stratified, or interaction analyses should be carried out. All of these points need to be discussed in relation to sex/gender to develop further recommendations for the future.

Sex/gender considerations in interventions promoting PA and/or reducing SB among children and adolescents are rarely reported. Policies and guidelines to best address promotion of PA and reduction of SB should be informed by intervention evidence that adequately takes sex/gender into account. In order to develop policies, guidelines, and programs that are more inclusive of all girls and boys, future intervention studies aiming to increase PA and reduce SB need to document sex/gender differences and similarities, and to explore whether sex/gender influences different phases of intervention programs, including implementation, acceptability, and perceived or actual barriers to participation. The newly developed sex/gender checklist could be a useful tool to facilitate documentation of sex/gender in future studies.

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4.2 Publication 2

Authors: Annegret Schlund, Anne K. Reimers, Jens Bucksch, Stephanie Linder, & Yolanda Demetriou

Title: Sex/Gender Considerations in School-Based Interventions to Promote Children's and Adolescents' Physical Activity: A Systematic Review

Journal: German Journal of Exercise and Sport Research

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Summary:

Physical inactivity is an increasing problem worldwide, but especially among girls. This difference by gender increases with age. Schools serve virtually all young people in most parts of the world and can thus play an important role in promoting PA. In this systematic review, we qualitatively and comprehensively assessed the treatment of sex/gender considerations (from study design to discussion of results) in 56 school-based intervention studies aiming to promote PA in children and adolescents. In all 56 studies, the factor of sex/gender was only rudimentarily considered, regardless of the effectiveness of the intervention. The meta-analysis revealed that the interventions had significant but relatively small effects with both girls and boys, along with high heterogeneity. To obtain better information about effective strategies that promote PA for both girls and boys equally, researchers conducting future intervention studies should pay attention to sex/gender differences and report on how they take this factor into account.

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Contribution:

Annegret Schlund prepared a draft of the manuscript. All authors were involved in the development of the sex/gender-checklist and the search strategy. Annegret Schlund performed the searches in consultation with Douglas M. Salzwedel and Lorri Pui. Annegret Schlund also extracted the data, conducted the screening of the search, appraised the study quality, and conducted the grading with the sex/gender-checklist. Stephanie Linder performed the meta-analyses. Anne K. Reimers, Jens Bucksch and Yolanda Demetriou supervised this process. All authors contributed to the interpretation of the results, critically reviewed the manuscript, and approved the final manuscript. Anne K. Reimers, Jens Bucksch and Yolanda Demetriou secured the funding for the study and conceived the genEffects project.

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Sex/gender considerations in school-based interventions to promote children's and adolescents' physical activity

A systematic review

Supplementary Information

The online version of this article (<https://doi.org/10.1007/s12662-021-00724-8>) contains supplementary material, which is available to authorized users.

Background

Schools are the most important educational institution for children and young people (WHO, 2018b). They are well positioned to reach children and young people of all ages and social classes in most parts of the world. Furthermore, schools can play an important role in promoting physical activity (PA). Within a school day, PA can be encouraged not only in physical education lessons, but also during active breaks between classes, at recess, or by implementing after-school programs (WHO, 2018b). Recommendations and policies concerning PA requirements and the promotion of PA in schools vary between countries (Aubert et al., 2018; Hills, Dengel, & Lubans, 2015; Rütten & Pfeifer, 2016). About 50% of schools worldwide can create an environment that provides sufficient PA on school days (Aubert et al., 2018). The quality and quantity of PA in schools are significantly correlated with sociodemographic indicators such as the human development index (HDI), the number

of years of schooling provided, or the degree of food security (Aubert et al., 2018). In some countries, schools are eliminating or reducing physical education to give more time to traditional academic teaching, despite existing evidence that physical education is conducive to academic success (Trudeau & Shephard, 2008).

Physical inactivity in children and adolescents can lead to physical and mental illnesses as well as to unfavorable social, physical, and cognitive health outcomes (Biddle, Ciacconi, Thomas, & Vergeer, 2019; Janssen & Leblanc, 2010; Kremer et al., 2014; McMahon et al., 2017; Poitras et al., 2016; Warburton & Bredin, 2017). Physical inactivity in young people often becomes a lifetime problem, as PA behavior is transferred from childhood and adolescence into adulthood (Telama et al., 2014). It is therefore important to begin encouraging children to adopt a more active lifestyle at an early age. Nevertheless, the prevalence of physical inactivity is high among children and adolescents and is even higher among girls than among boys. Only 15% of girls aged 11 to 17 and 22% of boys in that age group meet the World Health Organization's recommended guideline of 60 min of moderate to vigorous PA (MVPA) per day (WHO, 2019). In general, boys are more active than girls (Guthold, Stevens,

Riley, & Bull, 2020; WHO, 2018a) also during recess periods (Ridgers, Salmon, Parrish, Stanley, & Okley, 2012; Sarkin, McKenzie, & Sallis, 1997; Sato, Ishii, Shibata, & Oka, 2012).

Due to the large amount of time most children and adolescents spend at school, a portion of overall daily PA should be performed during school hours. Unfortunately, in most cases this does not happen, although opportunities for PA are often offered in various areas of everyday school life (e.g., recess, physical education, and after-school programs) (McKenzie, 2019).

Although differences in PA between boys and girls have been identified, the reasons for these differences vary and have not been fully captured. There is a strong tradition of research on gender and health that conceptualizes health behaviors (such as PA) as both shaped by and expressions of societal constructions of gender (Courtenay, 2000; Johnson & Repta, 2012; Saltonstall, 1993). In-

Abbreviations

PA	Physical activity
PRISMA	Preferred Reporting Items for Systematic review and Meta-analysis
SB	Sedentary behavior

Table 1 Eligibility criteria for the genEffects systematic review

	Included
Population	Healthy children and/or adolescents within the age range of 3 to 19 years
Intervention	Aim of the intervention must be the promotion of PA and/or reduction of SB by any type of quantified measure
Study design	Controlled intervention studies
Control group	No PA or SB intervention
Outcomes	PA and/or SB in all domains assessed by any type of measure (subjective/objective) <i>Descriptive or inferential statistical outcomes of PA/SB must be reported for one or more of the following:</i> for sex/gender disaggregated at baseline and/or follow-up and displayed in text and/or tables for sex/gender disaggregated in relation from baseline to follow-up and displayed in text and/or tables that there were no differences in the outcome when looking at sex/gender and no further analyses were carried out how they dealt with sex/gender in measuring the outcomes (e.g., adjustment)
Publication type	Peer-reviewed journal articles published in English, in or since the year 2000

PA physical activity, SB sedentary behavior

ingly, theoretical approaches to gender and health acknowledge that sex-based biological factors and gendered social factors are intertwined to the extent that it is not always possible to theoretically or empirically isolate the influence of each category of factors (Springer, Mager-Stellman, & Jordan-Young, 2012). To recognize this complexity, in this article we use the term “sex/gender” (Doull et al., 2014).

Sex/Gender differences in PA might be fostered and generated by interventions intended to promote PA in the school context. A review by Love, Adams, and van Sluijs (2017) described the effects of gender equality parameters on PA interventions for children. These parameters included gender, socioeconomic status, body mass index (BMI), ethnicity, place of residence, and religion. In a meta-analysis of accelerometer-assessed data, no effect related to sex/gender could be determined. Another systematic review by Love et al. (Love, Adams, & van Sluijs, 2019), which included 17 studies, found that school-based interventions to increase PA had no long-term effectiveness. In addition, no significant differences in intervention effectiveness related to sex/gender were observed. Mears and Jago (2016) found, in their systematic review of the effects of after-school interventions, that insufficient data on sex/gender differences were reported to en-

able quantitative analysis. Thus, until now, it is unknown where the differences in PA behavior between girls and boys come from, why interventions may increase them, and why interventions are only marginally effective.

Overall, sex/gender has received limited attention in interventions designed to promote PA (Love et al., 2017; Watson, Timperio, Brown, Best, & Hesketh, 2017). Since girls are less active than boys, we need to focus on intervention that promote PA in boys and girls in a similar way, so that boys and girls equally benefit from positive effects of PA. Differential effects in school-based PA interventions for boys and girls have been sporadically observed. Furthermore, up to now, sex/gender has been discussed mainly with regard to the effectiveness of interventions and not in terms of how the design, implementation, or analysis of the intervention could themselves produce differential effects. To reach reliable conclusions about how sex/gender affects interventions and their effectiveness, this oversight must be addressed. Therefore, this systematic review aims both to evaluate the effects of interventions to promote PA among girls and boys in the school context and to assess the extent to which these intervention studies took sex/gender into account in their design, implementation, and evaluation phases. Additionally, we conducted a meta-anal-

ysis to compare the intervention effects between girls and boys.

Methods

This paper is part of the genEffects systematic review, which seeks to analyze the effects of interventions to promote PA and/or reduce sedentary behavior (SB) in children and adolescents (Demetriou et al., 2019). The genEffects systematic review is reported according to PRISMA guidance (supplementary material 1) (Welch et al., 2012). The protocol for the genEffects review was published previously (Demetriou et al., 2019) and is also registered with PROSPERO (ref CRD42018109528). There were no protocol amendments for the present study, except that the GRADE framework was not used due to the narrative synthesis of data. The set of studies we reviewed was delimited to those that focused on interventions to promote PA in school. The consideration of sex/gender was assessed using a newly developed sex/gender checklist. Furthermore, a meta-analysis was conducted as noted in the previous paragraph.

Search strategy and eligibility criteria

Within the genEffects review, we searched the following eleven electronic databases: Cochrane Central Register of Controlled Trials (CENTRAL); Ovid MEDLINE; Epub Ahead of Print, In-Process and other Non-Indexed Citations, Daily, and Versions; Ovid Embase; Science Citation Index Expanded (SCI-EXPANDED); Clarivate Web of Science; Conference Proceedings Citation Index (CPCI-S); EBSCO PsycINFO; EBSCO Eric; EBSCO SPORTDiscus; and ProQuest Dissertations & Theses Global. The search included studies from January 2000 to August 2018, with a search strategy based on Cochrane standards (see supplementary material 2).

The search aimed to identify randomized and nonrandomized controlled trials of interventions to reduce SB and/or promote PA in children and adolescents age 3 to 19. Eligible studies were limited to peer-reviewed English-language

publications reporting a quantified measure of PA and/or SB. Studies primarily targeting children and adolescents with specific health issues were excluded, as were those that focused exclusively on college students. Additionally, we required all intervention studies to meet at least one of the following criteria: reporting PA separately by sex/gender at baseline and/or follow-up; explaining how sex/gender was addressed in outcome analyses (e.g., adjusting the analysis for sex/gender); and/or reporting on sex/gender similarities or differences among the outcomes. The comparators were either a control group with an activity that did not promote PA or reduce SB, or a control group without an intervention (▣ [Table 1](#)).

Study selection and data extraction

Two researchers performed the study selection process independently using Covidence software. All discrepancies were resolved by a third, senior researcher. After the removal of duplicates, titles and abstracts were screened, and all potentially relevant articles or those of undetermined relevance, were subsequently retrieved and screened against the eligibility criteria.

For each intervention study selected for inclusion, specific details were extracted by two reviewers independently. Data extraction covered general study characteristics (country, design, name of intervention program), sample size for intervention and control groups stratified by sex/gender and dropout rate, details of the intervention content, and intervention approaches and settings. Additionally, the extraction forms included information on the main outcomes of each intervention, measurement points and instruments, and statistical approaches, including the confounding variables taken into account in order to analyze the effectiveness of the intervention. For additional information, study protocols and supplementary material were used and in the case of missing information, authors were contacted (maximum of two contact attempts).

Quality assessment and risk of bias

Internal validity assessment was carried out independently by two reviewers using the Cochrane risk-of-bias tool for randomized trials, version 1 (Higgins et al., 2011; Higgins & Green, 2011). Discrepancies were resolved through discussion or through adjudication by a third reviewer if consensus was not reached. Primary studies were assessed across each of the five types of bias (selection, performance, attrition, detection, and reporting). Each domain was assessed as having a low, high, or unclear risk of bias, with the last category indicating either lack of information or uncertainty about the potential risk of bias. Nonrandomized controlled trials were considered to be at high risk of bias in domains related to randomization. To identify other potential risks, we examined the assessment of baseline differences between intervention and control groups, as well as seasonal differences in measurement points and monetary motivational incentives.

Sex/gender assessment

To assess the degree to which sex/gender was considered in the intervention studies, we used a newly developed sex/gender checklist (Demetriou et al., 2019). This sex/gender checklist consists of 10 items that analyzed background and concepts, study design, intervention planning and delivery, and presentation and interpretation of findings (▣ [Table 2](#)). Each item was rated with regard to the extent to which the study took sex/gender into account on that item, using three categories: “basic,” “detailed,” and “no information provided.” A fourth category, “not relevant,” was used for items that were considered not applicable to studies in which all subjects were of the same sex/gender (items MI, SSR, PF, and SR). On the first item, another rating category, “poor,” was applied to those studies that used the terms “sex” and “gender” interchangeably.

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Sex/gender considerations in school-based interventions to promote children’s and adolescents’ physical activity. A systematic review

Abstract

Physical inactivity is an increasing problem worldwide, but especially among girls. This difference by gender increases with age. Schools serve virtually all young people in most parts of the world and can thus play an important role in promoting physical activity. In this systematic review, we qualitatively and comprehensively assessed the treatment of sex/gender considerations (from study design to discussion of results) in 56 school-based intervention studies aiming to promote physical activity in children and adolescents. In all 56 studies, the factor of sex/gender was only rudimentarily considered, regardless of the effectiveness of the intervention. The meta-analysis revealed that the interventions had significant but relatively small effects with both girls and boys, along with high heterogeneity. To obtain better information about effective strategies that promote physical activity for both girls and boys equally, researchers conducting future intervention studies should pay attention to sex/gender differences and report on how they take this factor into account.

Keywords

Physical activity · School · Children · Adolescents · Gender

Data analysis and qualitative synthesis

We undertook a narrative synthesis to analyze differences and similarities between girls’ and boys’ PA in the interventions, based on their effectiveness with both sexes. Differences and similarities are reflected in the qualitative ratings obtained on the sex/gender checklist. In this analysis, we divided the studies into three superordinate groups. The first group consisted of studies with intervention effects in the same direction for girls and boys; this group was then subdivided into those with significant positive effects for

Table 2 Sex/gender checklist: categories, items and their definitions

Category	Item	Definition
Background and concepts	Definition and use of sex and/or gender terminology (DU)	Is the use of sex and/or gender terminology defined in the study?
	Sex/gender background information regarding the research question (e.g. prevalence, strength of association) (BI)	Is sex/gender background information regarding the research question taken into account?
	Theoretical and/or conceptual linkages with sex/gender (TCL)	Is sex/gender linked up with the theory/concept of the intervention?
Study design	Measurement instruments (MI)	Are the measurement instruments valid and reliable for sex/gender groups?
	Study sample recruitment (SSR)	Is the necessity of sampling for sex/gender taken into account?
Intervention planning and delivery	Intervention content and materials (e.g. brochures, leaflets, plans of sessions) (ICM)	Is/are the intervention content/materials inclusive with regard to sex/gender?
	Intervention delivery, location and Interventionists (IDLI)	Is the intervention sex/gender-inclusive with regard to the modes of intervention delivery, location, and the person carrying out the intervention (instruction/training of implementing persons to be aware of sex/gender-inclusive aspects such as sex/gender-inclusive language)?
Presentation of findings	Participant flow (PF)	Is a participant flow chart provided that takes sex/gender into account according to the CONSORT Statement (eligibility, estimation of sample size [baseline], dropout rates [post-test, follow-up])?
	Statistical results (SR)	Are sex/gender differences and/or similarities described regarding the outcomes?
Interpretation of findings	Discussion (D)	Is there reflection on the findings with respect to sex/gender?

girls and boys, those with significant negative effects for girls and boys, and those with no intervention effect for either sex/gender. Second, studies with different intervention effects for girls and boys were divided into four subgroups: positive significant effect for boys and no effect for girls, positive effect for girls and no effect for boys, negative effect for girls and no effect for boys, and negative effect for boys and no effect for girls. Third, among studies involving subjects of a single sex, we distinguished those that were effective from those that were not. In all three above-mentioned groups, the number of ratings of “detailed,” “basic,” “no information provided,” “poor,” and “not relevant” on every item of the checklist was calculated. By applying these analyses, we could compare the degree of sex/gender consideration between studies that were

or were not effective in affecting PA for both girls and boys, on one hand, with those that revealed different effects on PA for girls and boys on the other hand.

Meta-analysis

Meta-analytic procedures were performed using Comprehensive Meta-analysis Software, version 3 (Biostat Inc., Englewood, NJ, USA). The meta-analysis was conducted to determine the effect of school-based interventions to promote PA in children and adolescents for girls and boys separately. Randomized controlled trials (RCTs) and cluster RCTs with pre/post control-group design were included in the meta-analysis if the study either disaggregated the results by sex/gender or includes subjects of only one sex/gender. Nonrandomized controlled

studies were excluded, since random assignment is crucial for generating unbiased estimates of effects (Flay et al., 2005; Valentine & Thompson, 2013). If key information for the calculation of Hedges' g was missing or if studies failed to report the results for boys and girls separately, a study was eliminated from the analyses. The main data entry format used for calculation of effect size was mean, standard deviation, and sample size for each group. A random-effects model was chosen to account for heterogeneity across the studies (Hedges & Olkin, 1985; Hedges & Vevea, 1998). Heterogeneity was analyzed by calculating the Q -statistic and the I^2 -statistic. The four included cluster RCTs were assessed for unit-of-analysis error their handling of adjusting for the clustering effect in the analyses (Campbell, Elbourne, & Altman, 2004; Eldridge, Ashby, Feder, Rudnicka, & Ukoumunne, 2004).

Publication bias was tested by the visual inspection of the funnel plot (an asymmetric, as opposed to a symmetric inverted, funnel shape indicated potential publication bias) and Egger's test of the intercept to quantify the bias captured by the funnel plot and whether it was significant ($p \leq 0.05$).

Several subgroup-moderator analyses were conducted according to the mixed-effects model. Two analyses concerning outliers were conducted by excluding (1) studies with the highest and lowest effect size and (2) studies with values of Hedges' g not located within the 95% confidence interval of the random-effects model. Three further subgroup analyses were conducted: study sample (single sex/gender versus mixed sex/gender), PA (measured only during school time as opposed to being measured through the whole school day), and study design (RCT versus cluster RCT).

Results

In total, 58 articles reporting 56 unique school-based intervention studies with school PA as a primary outcome were included in our analyses (see supplementary material 3). Originally, in the gen-Effects systematic review, we identified 24,878 references through the electronic

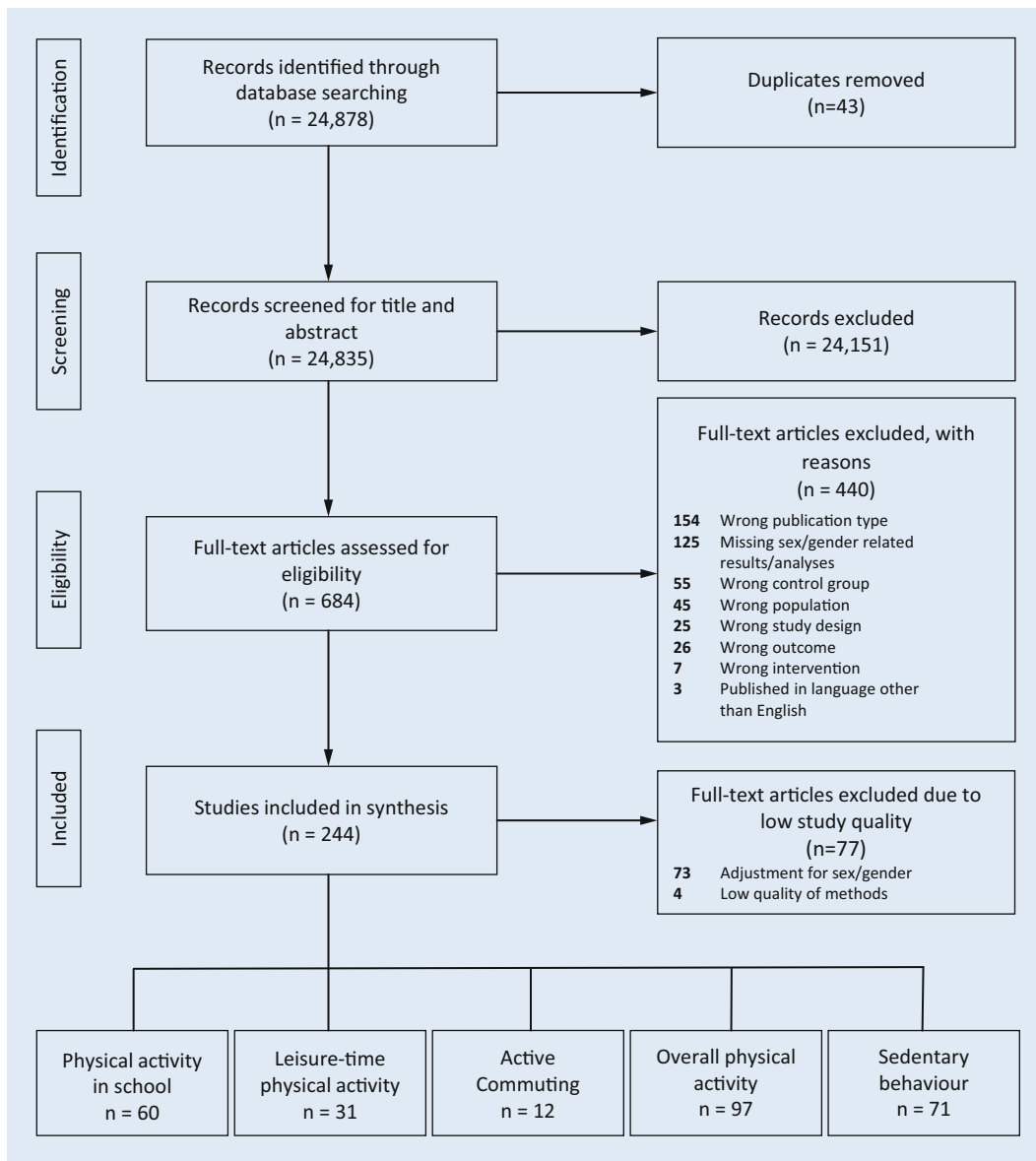


Fig. 1 ◀ PRISMA flowchart

database search, leading to the inclusion of 244 articles reporting 217 unique studies (Fig. 1). We identified two publications each for two of the included interventions (Christiansen et al., 2017; Ha, Burnett, Sum, Medic, & Ng, 2015; Ha, Lonsdale, Ng, & Lubans, 2017; Toftager et al., 2014).

The included studies were categorized as either cluster RCTs ($n = 30$; 53.6%), RCTs ($n = 14$; 25.0%), or involving nonrandomized intervention and control groups ($n = 12$; 21.4%). In the included studies, the mean age was 10.9 ± 2.8 years (median = 10.7 years; minimum = 6.0 years; maximum = 18.4 years). The mean duration of the in-

terventions was 46.7 ± 49.9 weeks (median = 30 weeks; minimum = 1 week; maximum = 208 weeks).

Risk of bias of primary studies

The risk of bias of each of the 56 studies was rated using the Cochrane risk-of-bias tool (Higgins et al., 2011; Higgins & Green, 2011). We analyzed the frequency with which each risk rating level occurred across all domains and studies, finding high risk of bias in 27.8% of all ratings, unclear risk in 30.6%, and low risk in 41.6% (Fig. 2). The risk-of-bias assessment for each included study is provided in supplementary material 4.

Overall sex/gender analysis of primary studies

Of the 56 studies, 19 (33.9%) reported results in a disaggregated manner for boys and girls separately; 18 (32.4%) analyzed sex/gender through interaction analyses (group allocation \times time \times sex/gender); 12 (21.4%) tested for differences or similarities in sex/gender at baseline or follow-up or via interaction analysis but did not find any (no effect size shown); and 7 (12.5%) included and analyzed girls only. No study included boys only. The consideration of sex/gender for each included study is provided in supplementary material 5.

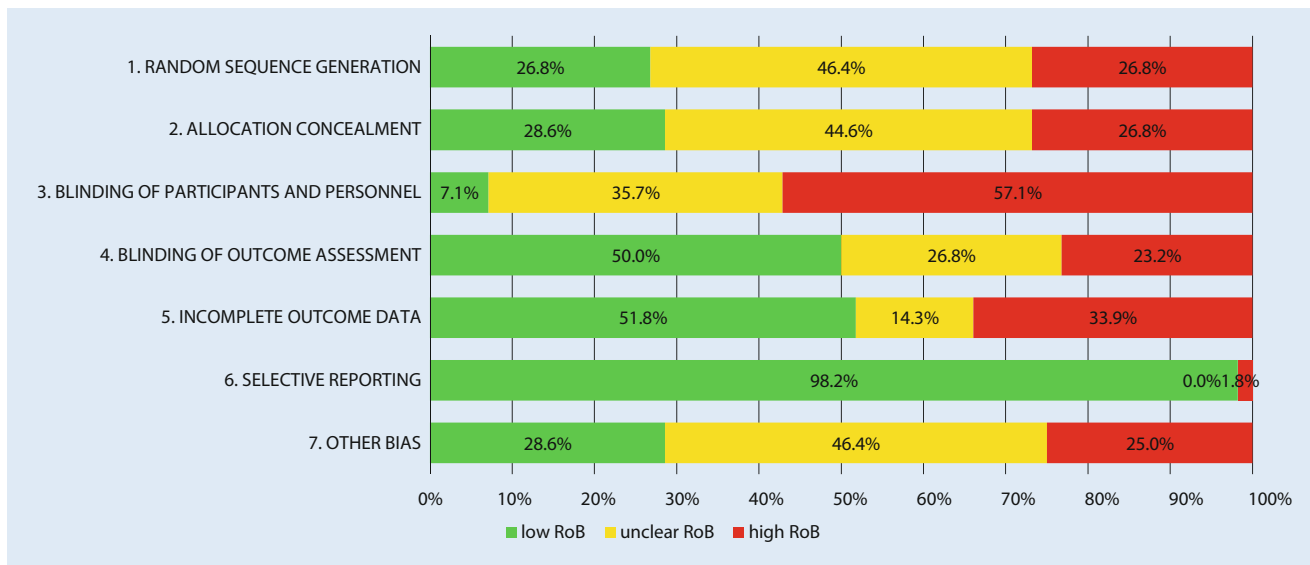


Fig. 2 ▲ Risk of bias (RoB) for all 56 school physical activity (PA) studies

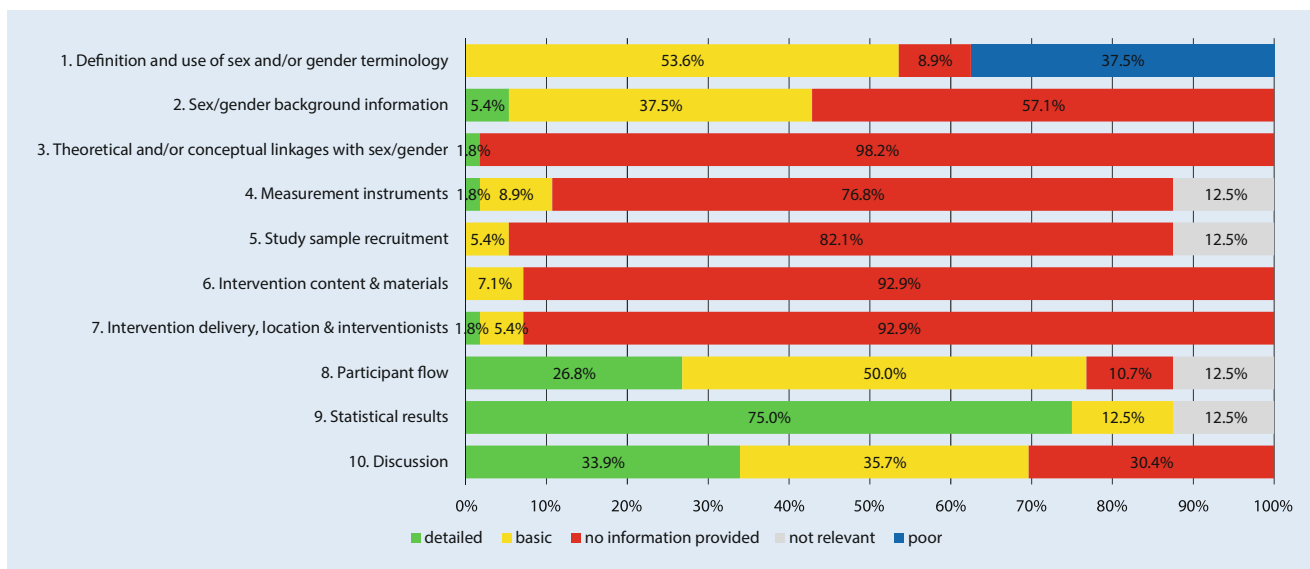


Fig. 3 ▲ Sex/gender assessment of all 56 school physical activity (PA) studies

The sex/gender assessment for each item according to the sex/gender checklist is provided in Fig. 3. Due to the inclusion criteria, the item *Statistical results (SR)* was the one rated most frequently as “detailed” ($n = 42$; 75.0%). The item rated most frequently as “no information provided” was *Theoretical and/or conceptual linkages with sex/gender (TCL)*, in 55 (98.2%) studies. No study was rated as “detailed” on the items *Definition and use of sex and/or gender terminology (DU)*, *Study sample recruitment (SSR)*, or *Intervention content and materials (ICM)*.

In the items *MI*, *SSR*, *ICM*, and *IDLI* (all in the intervention delivery category), we found that most of the studies provided no information about sex/gender. The specific percentages were as follows: *Measurement instruments (MI)*, $n = 43$, 76.8%; *Study sample recruitment (SSR)*, $n = 46$, 82.1%; *Intervention content and materials (ICM)*, $n = 52$, 92.9%; *Intervention delivery, location, and interventionists (IDLI)*, $n = 52$, 92.9%.

Intervention effectiveness in terms of sex/gender

Semiquantitative analysis. First, 41 studies found that the intervention had the same effect on both girls’ and boys’ PA. In 27 studies, the intervention effect was significantly positive for girls and boys of the intervention group; in two studies (Fairclough et al., 2016; Ha et al., 2015), the control group was favored (Fig. 4); in 12 studies, no intervention effect could be found on girls’ and boys’ PA. The two studies favoring the control group had “detailed” ratings on the sex/



Fig. 4 ▲ Sex/gender assessment—semi quantitative analysis of all 56 school physical activity (PA) studies

gender checklist 10.0% percent of the time, less than those with a positive effect (15.2%; $n = 41$); studies with no significant intervention effect had the highest proportion of “detailed” ratings, with 18.3% ($n = 22$). Studies favoring the intervention group were more likely to provide information about considering sex/gender (74.4%) than studies with negative effect (12.6%) or no effect (13.3%). About one-third of the studies with same effect for girls and boys were rated as “detailed” on *Participant flow (PF)* and *Discussion (D)*, and 85.4% ($n = 35$) of the 41 studies were rated as “detailed” on *statistical results (SR)*. In all other items, sex/gender was only occasionally considered as “detailed.”

Different intervention effects for girls and boys were found in eight intervention studies. In four studies was no effect for girls and a significant effect for boys (Christiansen et al., 2017; Haerens et al., 2006; Loucaides, Jago, & Charalambous, 2009; McKenzie et al., 2004); no effect for girls and a negative effect for boys once (Elder, McKenzie, Arredondo, & Cre, 2011); no effect for boys and a negative effect for girls was shown once (Verloigne et al., 2012); and a positive intervention effect for girls and no effect for boys was also reported once (Bleeker, Beyler, James-Burdumy, & Fortson, 2015; Verstraete, Cardon, De Clercq, & De Bourdeaudhuij, 2006). In this group of studies,

none was rated as “detailed” on any of the first seven items (DU, BI, TCL, MI, SSR, ICM, IDLI) except Bleeker et al. (2015) on item BI. Overall, 14 (17.5%) ratings of “detailed” were given by these studies; a rating of “basic” was given 19 (23.8%) times; in 45 cases (56.3%), the rating of “no information provided” was selected; and just two studies had the rating “poor” (Christiansen et al., 2017; McKenzie et al., 2004). On items TCL, ICM, and IDLI, no information about sex/gender was provided by any of these studies. On item SR, all studies considered sex/gender when reporting the statistical results except Bleeker et al. (2015), which was rated as “basic” in this regard. Overall, studies that were more successful for girls than for boys (significant positive effect for girls or negative effect for boys) had ratings of “detailed” more often (20.0% in both cases) than studies that were more successful for boys than for girls (significant positive effect for boys, 17.5%; negative effect for girls, 10.0%).

Among all the studies that considered only a single sex/gender, as noted above, only seven studies with girls as the target group met the inclusion criteria. A significant positive intervention effect was reported in four of these studies (Carlin, Murphy, Nevill, & Gallagher, 2018; Fairclough & Stratton, 2006; Guagliano, Lonsdale, Kolt, & Roser, 2015; Schneider et al., 2007) but not in the other three.

Items MI, SSR, PF, and SR were excluded from consideration because these are not relevant to studies of a single sex/gender. Only the three studies with no intervention effect were rated as “detailed” on *Discussion (D)* because of their consideration of sex/gender in the discussion (Dewar et al., 2014; Dudley, Okely, Pearson, & Peat, 2010; Okely et al., 2017). Among the 13 ratings (31.0%) in the basic category, nearly half were on item BI, where six out of seven studies provided sex/gender background information regarding the research question; the most frequently mentioned background statement was that girls are significantly less physically active than boys (Carlin et al., 2018; Dewar et al., 2014; Dudley et al., 2010; Guagliano et al., 2015). On 26 occasions (61.9%), no information was provided about the consideration of sex/gender. Overall, in this group of studies, sex/gender was considered less frequently than in all other studies, regardless of the effectiveness of the studies.

Meta-analyses

An overview of the two calculated meta-analyses is provided in **Table 3**, including the effect size statistic, the heterogeneity statistic, the analysis of publication bias, and the subgroup analyses.

Table 3 Random effects model of Hedges' *g* for school-based physical activity (PA) interventions and subgroup analyses

Girls only						
Variables	Effect size statistic			Null test Z	Heterogeneity	
	k	<i>g</i>	95% CI		Q	<i>I</i> ²
Overall Effect	10	0.386	(0.178, 0.594)	3.630**	105.304**	91.45
Outliers	7 ^B	0.346	(0.183, 0.509)	4.167**	16.774*	64.23
High/Low	8 ^A	0.301	(0.130, 0.471)	3.452**	29.925**	76.61
Study Design	–	–	–	–	1.667 ^C	–
RCT	3	0.176	(0.025, 0.327)	2.281*	0.198	0.00
C-RCT	5	0.369	(0.117, 0.621)	2.869**	28.352**	85.89
PA outcome	–	–	–	–	0.105 ^C	–
School	4	0.274	(0.004, 0.543)	1.989*	18.219**	83.53
Overall	4	0.336	(0.077, 0.595)	2.539**	11.697**	74.35
Participants	–	–	–	–	1.922 ^C	–
Mixed	5	0.366	(0.155, 0.578)	3.401**	16.624**	75.94
Single	3	0.156	(–0.055, 0.366)	1.451	3.765	46.88
Boys only						
Variables	Effect size statistic			Null test Z	Heterogeneity	
	k	<i>g</i>	95% CI		Q	<i>I</i> ²
Overall Effect	5	0.277	(0.181, 0.372)	5.665**	0.842	0.00
High/Low	3 ^A	0.271	(0.155, 0.386)	4.583**	0.503	0.00
Study Design	–	–	–	–	0.069 ^C	–
RCT	2	0.292	(0.145, 0.438)	3.896**	0.101	0.00
C-RCT	3	0.266	(0.139, 0.392)	4.121**	0.672	0.00
PA outcome	–	–	–	–	0.134 ^C	–
School	1	0.298	(0.150, 0.446)	3.947**	0.000	0.00
Overall	4	0.262	(0.136, 0.387)	4.080**	0.708	0.00

k number of effect sizes; *g* effect size (Hedges' *g*); 95% CI confidence intervals (lower limit, upper limit); Z test of null hypothesis; *I* total variance unexplained by moderator
* indicates $p < 0.05$; ** indicates $p < 0.01$
^AGirls only: removal of Guagliano et al., 2015; Okely et al., 2017; boys only: removal of Verstraete et al., 2006; Haerens et al., 2006
^BRemoval of Guagliano et al., 2015; Okely et al., 2017; Dewar et al., 2014
^CBetween Q-value used to determine significance between subgroups ($\alpha < 0.01$)

Intervention effects in girls

Ten studies provided sufficient data to be included in the meta-analysis. The overall pooled effect size was significantly positive and small, and heterogeneity was high (see [Table 3](#)). These results suggest that girls exposed to the PA intervention treatment participated in more PA than those in the control condition. The effects from the included studies were extremely inconsistent, ranging from $g = 0.006$ (61) to $g = 1.592$ (59) ([Table 3](#)). Of the ten included studies, five (Carlin et al., 2018; De Barros et al., 2009; Dudley et al., 2010; Parrish, Okely, Batterham, Cliff, & Magee, 2016) reported a small effect and two (55, 62) reported a large effect.

To explore whether the subgroups moderated the average intervention effect, a series of subgroup analyses was performed. Excluding outliers resulted in a slightly smaller effect size and reduced heterogeneity. The subgroup analysis of the study design did not differ significantly ($p = 0.197$), and it showed that RCTs resulted in a small effect size and no heterogeneity. When only cluster RCTs were analyzed, the effect size was higher, with high heterogeneity. As for the study sample, the assessment of Hedges' *g* resulted in a low effect size for both studies with subjects of mixed sex/gender and those with girls only. Studies using mixed designs exhibited higher heterogeneity than single-sex/gender studies. The subgroup analysis of the PA

measurement showed that assessing PA during the whole day produced a low effect size of Hedges' *g* and high heterogeneity. In comparison, measuring only school-based PA resulted in a low effect size, but higher heterogeneity. The inspection of the funnel plot indicated more positive than negative comparisons and therefore some possible publication bias; also, Egger's regression test was significant.

Intervention effects in boys

Five studies were eligible for inclusion in the meta-analysis (De Barros et al., 2009; Grydeland et al., 2013; Haerens et al., 2006; Parrish et al., 2016; Verstraete et al., 2006). The average treatment effect was significant but small, and heterogeneity was low. These results suggest that boys exposed to PA interventions participated in more PA than those in the control condition ([Table 3](#)). Excluding the comparison with highest and lowest effect sizes (Haerens et al., 2006; Verstraete et al., 2006) resulted in a slightly smaller effect size and no heterogeneity ([Table 3](#)). No study was located outside the 95% confidence interval with regard to the overall effect.

The subgroup analysis by study design among boys did not reveal any significant difference ($p = 0.792$). RCTs resulted in a small effect size and no heterogeneity. For cluster RCTs, the effect size was small without heterogeneity. When we analyzed PA over the whole school day, a small effect size was found with no heterogeneity. There were no studies of boys only. The visual inspection of the funnel plot was balanced, and Egger's regression test was not significant ([Table 3](#)).

Discussion

This systematic review assessed the consideration given to sex/gender factors in the development, implementation, and evaluation stages of 56 school-based intervention studies that aimed to promote PA in children and adolescents. In all studies, sex/gender was considered only rudimentarily across all items of the sex/gender checklist, regardless of the effectiveness of the intervention. Addition-

ally, the meta-analyses examining the intervention effects for girls and boys separately revealed that the interventions were successful in both girls and boys, but with small significant effects and high heterogeneity.

Most children and adolescents of all ages and from all social classes are attending school. Therefore, the school offers an important setting to promote PA, not only through physical education but also during recess, regular classes, or after-school programs (WHO, 2018b). Positive significant intervention effects were achieved only for girls in 3.6% of the studies and only for boys in 7.1% of the studies. In 48.2% of the studies, positive intervention effects on the PA levels of both girls and boys were found. No effect on either sex/gender occurred in 21.4% of the studies. Negative effects were found in 7.2% of the studies. Single sex/gender studies had in 5.4% of the studies no effect and a positive effect in 7.1%.

Overall, sex/gender aspects received minimal consideration regardless of whether the studies had the same intervention effect on girls and boys, had different effects on girls and boys, or included girls only in their sample (Love et al., 2017). Overall, only the statistical analyses addressed sex/gender in greater detail. These findings lead us to conclude that research studies are more likely to consider sex/gender in their analyses of intervention effectiveness and discussions than in the planning, design, development, and implementation of the study. Notably, studies of girls only that found a positive intervention effect ($n=4$) considered sex/gender even less frequently than those with different intervention effect. These four studies did not provide information about consideration of sex/gender in 70.8% of the ratings over all items of the checklist (Carlin et al., 2018; Fairclough & Stratton, 2006; Guagliano et al., 2015; Schneider et al., 2007). One likely reason for this omission is that explicit discussion of comparisons with the opposite sex/gender may seem unnecessary in studies where all subjects are of the same sex.

Studies with different intervention effects on girls and boys were rated very similarly based on the checklist. None of these studies gave any information regarding the consideration of sex/gender on the checklist items that describe the theoretical and conceptual linkages with sex/gender, the measurement instruments, or how sex/gender was considered in study sample recruitment, intervention content and materials, or the selection of people carrying out the intervention. This means that in these studies, sex/gender was not considered in either the planning or the implementation of the intervention. Only in the results of the intervention did differences emerge, and they were then discussed by 88.0% of the studies. These findings indicate strongly that sex/gender should be taken into account at earlier stages of the study (i.e., in planning and implementation). All studies that found significant positive effects only in girls addressed sex/gender issues in the discussion; in contrast, among the studies that identified significant positive effects only in boys, just one-quarter considered issues of sex/gender when discussing the results. In other words, if an intervention is effective only with girls, the difference by sex/gender attracts researchers' attention more strongly than if it is effective only with boys. This could be because PA is generally more prevalent among boys than among girls (Guthold et al., 2020; WHO, 2018a), with the result that intervention programs that improve PA only among girls highlight the differential impact by sex/gender most vividly.

The results of the meta-analyses showed that the interventions were successful with both girls and boys, even though the effect sizes were small and the heterogeneity between studies was very high throughout all studies. The meta-analysis of the effects on girls revealed a publication bias, in that the analyzed intervention studies are very different with regard to the implementation, measurement methods, and statistical analyses. Nevertheless, the results of our meta-analyses show that interventions conducted in a school context can increase PA among girls and boys. This finding indicates that such interventions are

generally useful, although the validity of the meta-analysis was limited (Love et al., 2019).

Even if a PA intervention seems to work for both girls and boys, however, it is necessary to consider more carefully the target and the components of an intervention so as to assure effectiveness for girls and boys because there is always a risk of reinforcing inequalities. Sex/gender must therefore always be taken into account, otherwise unintended disadvantages or reinforcements of inequalities may result (Nieuwenhoven & Klinge, 2010; Verscheure & Amade-Escot, 2007).

Only further replication, with documentation of the content, components, and implementation of the intervention, can determine whether the sex/gender of teachers or caregivers has an influence on the promotion of PA, or whether girls and boys should be educated separately. Sigmund, El Ansari, & Sigmundova (2012) was the only study that received a rating of "detailed" on the item *Intervention delivery, location and interventionists (IDLI)* because this study reported that when girls and boys played separately and/or together, girls and boys chose different activity types, equipment, and content during co-educational teaching. This intervention was effective for both girls and boys. To find out whether this feature of the study (i.e., permitting girls and boys to play in different ways) was a reason why the intervention had positive impact on both girls and boys, further research would be needed, since we have just one study illustrating this pattern. On the item *Intervention content and materials (ICM)*, no study received a "detailed" rating and four were rated as "basic" (Engelen et al., 2013; Fairclough et al., 2016; Okely et al., 2017; Sigmund et al., 2012) because they considered sex/gender in a limited way—for example, by providing differential materials for boys and girls (Engelen et al., 2013). The effects of these differences between the materials were not reported, however, so we have no ability to draw conclusions about the importance of the materials used. For example, it might be relevant what color, what language the materials had that were used in the interventions. Information is needed on

how the children were addressed, if boys and girls were addressed equally or separately and if the interests and needs of both girls and boys were considered when developing the program. Based on this information, in a further step we can find out what works for boys, what works for girls and what works for everyone.

Another way to increase PA for both girls and boys, or at least to determine more clearly what interventions work for each sex/gender, could be to adopt school PA policies that contain sex/gender considerations (McKenzie, 2019).

Strengths and limitations

To the best of our knowledge, this review paper is the first to systematically analyze the consideration of sex/gender in intervention studies intended to promote PA in a school context, in relation to the effectiveness of the interventions. Another unique strength of this study was the use of the sex/gender checklist, which provided detailed information on the extent to which sex/gender was considered in each study and permitted comparison with the narrative interpretation of effects. The use of the PRISMA statement is another strength, as it ensured the methodological quality of the systematic review. Moreover, the meta-analyses provided further insights into the effectiveness of interventions in the school context with regard to sex/gender.

One limitation of this systematic review is that it encompassed only English-language articles. Furthermore, the checklist assesses whether sex/gender was discussed, but not the quality or extent of the discussion. In addition, it is not possible to assess whether sex/gender was not considered at all in a particular intervention study or whether it was just not reported; the inability to make this distinction could introduce a bias into the results. Another limitation is that only a small number of studies could be included in the meta-analysis, limiting its generalizability. Since no sex/gender-diverse participants were included in the studies examined in this systematic review, we were limited to binary sex/gender characterization.

Conclusion

In general, we found insufficient consideration of sex/gender in intervention studies in the school context to increase physical activity (PA) among children and adolescents. Studies that found significant positive intervention effects did not differ in their extent of consideration of sex/gender from those that did not find significant intervention effects, nor did studies that found the same effect on girls and boys differ from those that reported different effects on girls and boys. Current research shows a clear difference in the physical activity and sedentary behavior between girls and boys (Kalman et al., 2015; WHO, 2018a). These differences in behavior can have severe health consequences (Biddle et al., 2019; Janssen & Leblanc, 2010). Only by better understanding the differences and similarities in the physical activity and sedentary behavior of girls and boys can we contribute to enhance positive behaviors and counteract the physical inactivity pandemic. For this, a clear documentation of relevant sex/gender aspects during the design, implementation and evaluation of intervention programs and for the conduct of systematic reviews is crucial.

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Declarations

Conflict of interest. A. Schlund, A.K. Reimers, J. Bucksch, S. Linder and Y. Demetriou declare that they have no competing interests.

For this article no studies with human participants or animals were performed by any of the authors. All studies performed were in accordance with the ethical standards indicated in each case.

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5 General Discussion

The aim of this dissertation was to evaluate intervention studies promoting PA and/or reducing SB in adolescents regarding their consideration of sex/gender. By using the newly developed sex/gender checklist, the presented studies showed the lack of information regarding sex/gender, because in nearly all studies sex/gender was only rudimentarily considered. Detailed information about sex/gender was found especially in statistical analyses and discussions of studies. To draw conclusions what kind of interventions can support children's and adolescent's behavior, we need more information about sex/gender from the development and implementation of intervention studies. However, the meta-analysis showed that intervention studies can help boys and girls to create an active environment for both.

In general, the developed sex/gender checklist helps to assess the degree of consideration of sex/gender in studies in systematic reviews. The high average of "no information provided" throughout all 217 included studies might be surprising as sex/gender differences in PA are known since many years (Guthold et al., 2020).

When reviewing the results of the studies it is striking that especially in the planning of the intervention studies sex/gender plays a subordinate role. In some studies it is mentioned that differences in the PA levels of girls and boys are given (Bleeker et al., 2015; Grydeland et al., 2013; Vasickova et al., 2013). However, the differences are often not considered further with regard to the planning or implementation of the intervention so that this statement represents little added value in the studies and research.

Until recently, sports for women were considered unseemly, and especially intense athletic activity (Pfister, 2017). Even today, women are associated with different sports than men. Furthermore, men's sports experience a much wider reach than women's sports, which becomes clear every when looking at audience sizes. A men`s team soccer match receives a much higher market share of 44,7 % in comparison to a women`s match with 15,8 % and the audience size of a men`s match is six times bigger than a women`s match (Meier & Leinwather, 2012). This implies that women's soccer is less recognized, less known, and as a result, fewer female role models emerge and girls are less motivated to participate in kind of sports such as soccer. It is important to identify the sex/gender gap in sports, to analyze it and to implement the knowledge about it into new interventions. Only when we know which sports inspire girls most, they can be motivated and addressed to be more active effectively.

One implication of this work for sports science and researchers is that this inequality exists and that one is aware of it. The conclusion from this knowledge is to take it into account as best as possible to all research projects.

5.1 Limitations

As mentioned in the beginning of this thesis, sex/gender includes biological and physical processes as well as gender roles and gender identities (Doull et al., 2014). In all of the included studies sex/gender was binary divided in boys and girls. Thereby it was not possible to include persons who do not identify with the male or female sex/gender. This is why the studies included in this thesis are limited to this categorization. However, this is done for statistical reasons, among others,

because subgroups with very few test persons (e.g. transgender) do not allow statistical significance. For the claim of a representative sample, however, this should be considered in any case, since the proportion of Bisexual, Transgender or Queer persons is now much higher than 20-30 years ago (Jones, 2021). Therefore, research must also open up and address this static problem in the future.

In the publications included in this thesis 217 studies from all over the world were encompassed, whereas in this thesis only English-speaking articles were included. The consequence is, that further interventions could have been included that would have changed the outcome of the studies.

The developed sex/gender checklist assesses the consideration of sex/gender in the planning, conducting and evaluation of an intervention promoting PA and/or reducing SB. However, the checklist can only be used to evaluate what has been documented in the articles. It is possible that due to a lack of space or similar, important information on the consideration of sex/gender was not named in the articles and therefore could not be evaluated.

In the second article included in this thesis, several meta-analyses were performed. Only a few studies could be included (boys $k = 5$; girls $k = 10$). The studies are very heterogeneous, which makes comparison difficult. This limits the validity of the meta-analyses. A publication bias was also found among the girls. This can be explained by the differences in implementation, measurement methods, and statistical analyses.

5.2 Future Research Perspective

Due to the COVID-19 Pandemic negative and positive effects in PA promotion could be seen (Gelius et al., 2021). There is need for action regarding the negative impact on PA opportunities. Children had and still have to stay more at home and usual activities were skipped due to the virus. In contrast, the positive effects should be exploited, that due to the fewer opportunities more awareness for PA has emerged in society and politics (Gelius et al., 2021). In a second way the gender specific impact of the COVID-19 pandemic should be analyzed. The question that arises here is whether gender gaps have widened further or perhaps narrowed since March 2019.

Furthermore, the trends of sports change with time. While gymnastics, cycling and rowing were popular 100 years ago (Rohner, 2018), today soccer and basketball are the most popular sports for boys in Germany and girls are more into dancing and horseback riding (Kuhlmann, 2021). Therefore, future research studies must evaluate what kind of sports can motivate both girls and boys to be more physically active. They need to carefully analyze if it is the same kind of sport for both sex/genders like basketball or do we need to offer sex/gender specific interventions like dance sports for girls and soccer for boys. We need more information about if and how the sex/gender of teachers or interventionists influences the behavior of girls and boys. Do we need female teachers for girls and male teachers for boys or is this inverted or unnecessary? The same applies for the design of playgrounds, the design of schools and teaching materials. Do these have to be sex/gender-specific or rather sex/gender-neutral?

As shown in the beginning of this thesis, sex/gender differences are to some extent also raised by society or are historically rooted in society (Pfister, 2017). Currently, we do not know to what extent and in what direction society influences the PA behavior of girls and boys. In terms of PA, it means that girls move less than boys, which has health implications.

At the moment, the research focusses the promotion of PA in the ages of 10-14 years (van Sluijs et al., 2021). It is an interesting point how the needs of different sex/gender develop with age or how the needs of sex/genders evolve with it. Here we need to further explore whether, for example, it is more effective to design interventions for boys and girls together in childhood or separately for girls and boys in adolescence. It must be examined whether there are different needs for adolescent girls and boys in terms of persons who carry out the interventions, the content or materials.

Of particular importance are intervention studies promoting PA and/or reducing SB which consider sex/gender from the beginning of planning throughout the implementation until the evaluation of the results. The present work as well as the checklist should help to show the actual situation and to systematically address the sex/gender differences in systematic reviews. In this way, both in science and in society, the awareness of the problem will be increased and further measures can be taken. This includes further awareness raising through the dissemination of the checklist and, to plan and conduct further reviews and furthermore, the planning and implementation of interventions that aim to increase PA in children and adolescents and in particular take into account sex/gender differences. The developed sex/gender checklist can provide a good framework to consider

sex/gender in all important points of an intervention. Beyond that, the documentation of the consideration of sex/gender is an important point. The documentation allows researchers to analyze whether and to what extent the considerations have had an effect. We need to figure out how interventions need to consider sex/gender to be most effective in girls and boys. Here, the items of the checklist can give an orientation in the planning process to make all possible important points apparent. For the future, it would be important to establish that sex/gender specific information, as systematically listed in the sex/gender checklist, is included as a matter of course in scientific publications. If the checklist is used regularly in the development of systematic reviews and of interventions, important data can be collected in the future to help minimize sex/gender differences and help both, girls and boys to be more physically active.

In the future, the field of sex/gender research, especially gender roles, is predicted to evolve. The previous binary distribution of male and female will be expanded by more sex/gender categories such as diverse. This is an important point and must be taken more into account in the future, for example, when creating questionnaires and collecting personal data from participants.

6 Conclusion

Today, most children and adolescents do not reach the World Health Organization recommendations on PA and compared to boys, girls are at an even higher risk of being less physically active. This sex/gender difference is due to biological conditions and social constructs (e.g., history, education) or reinforced through expectations by society, which can influence entire generations in their lifestyles including PA behavior. Many interventions have been conducted aiming to promote PA and/or to reduce SB but their effectiveness was rather low and the cause has remained unclear.

Therefore, this thesis examined interventions aiming to promote PA with a special focus on their consideration of girls and boys in order to identify effective intervention strategies how to achieve gender equality as otherwise, PA-related health benefits might be withheld from girls. After developing a sex/gender checklist and applying it to assess existing intervention studies, this thesis revealed a marginal consideration of sex/gender in published intervention studies. For most items of the sex/gender checklist, information about how intervention studies considered sex/gender was only rudimentarily reported, especially with regard to the theoretical background. Many intervention studies only considered sex/gender in their flow diagram of participants, statistical analysis, and/or discussion. However, more information about how sex/gender was considered in the development and implementation of intervention studies is needed prior to drawing final conclusions on what helps to achieve gender equality in children and adolescents with regard to their PA behavior.

The conducted meta-analyses found significant but small effects in both girls and boys. Furthermore, heterogeneity was high in both.

In line with the vision that girls and boys should have equal chances of being physically active, effective intervention strategies aiming to promote PA and/or reduce SB in both girls and boys need to be identified. The newly developed sex/gender checklist in this thesis contributes to closing this research gap and achieving gender equality in the promotion of PA and/or reduction of SB.

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8 Appendix

8.1 List of Publications

1. Schlund, A., Reimers, A. K., Bucksch, J., Brindley, C., Schulze, C., Pui, L., Coen, S. E., Phillips, S. P., Knapp, G., & Demetriou, Y. (2021, Mar 5). Do Intervention Studies to Promote Physical Activity and Reduce Sedentary Behavior in Children and Adolescents Take Sex/Gender Into Account? A Systematic Review. *Journal of Physical Activity & Health, 18*(4), 461-468. <https://doi.org/10.1123/jpah.2020-0666>
2. Schlund, A., Reimers, A. K., Bucksch, J., Linder, S., & Demetriou, Y. (2021). Sex/gender considerations in school-based interventions to promote children's and adolescents' physical activity. *German Journal of Exercise and Sport Research, 51*(3), 257-268. <https://doi.org/10.1007/s12662-021-00724-8>

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