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Intervention Strategies for the Promotion of Physical Activity in Youth

Interventionsmaßnahmen zur Förderung körperlicher Aktivität bei Kindern und Jugendlichen

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ZUSAMMENFASSUNG

Da es enge Zusammenhänge zwischen unzureichender körperlicher Aktivität und vielen chronischen Krankheiten gibt, ist Bewegungsmangel eines der führenden Probleme der Gesundheitssysteme in modernen Gesellschaften. In der Entwicklung von Kindern und Jugendlichen nimmt mit dem Alter die körperliche Aktivität deutlich ab. Deshalb ist eine frühzeitige Förderung eines aktiven Lebensstils notwendig. In den vergangenen Jahren wurden eine Vielzahl von Interventionsmaßnahmen zur Förderung der körperlichen Aktivität bei Kindern und Jugendlichen entwickelt, wobei generell zwischen Verhältnisänderung (z.B. bewegungsfördernde Pausenhofgestaltung) und Verhaltensänderung (z.B. gesundheitsbezogene Wissensvermittlung) unterschieden wird. Die Schule hat dabei eine zentrale Bedeutung, da hier viele Schüler über einen längeren Zeitraum erreicht werden können. Ebenso wichtig ist die Einbeziehung der Familie, da die Eltern einen wesentlichen Einfluss auf das kindliche Verhalten haben. Die Datenlage zur Effektivität verschiedener Interventionsmaßnahmen ist leider nicht immer eindeutig. Mehr-Ebenen-Interventionen mit Kombination verschiedener Verhältnis- und Verhaltensinterventionen zeigen insgesamt bessere Ergebnisse. Ziel dieser Übersichtsarbeit ist es einen Überblick über unterschiedliche Interventionsmaßnahmen zur Förderung körperlicher Aktivität bei Kindern und Jugendlichen zu geben und die Effektivität einzelner Maßnahmen zu diskutieren. Dazu werden ausgewählte Maßnahmen zur Förderung der körperlichen Aktivität bei Kindern und Jugendlichen aus den Bereichen Kommune, Schule und Familie vorgestellt, welche sowohl Verhaltens- als auch Verhältnisänderung zum Ziel haben. Obwohl der Fokus auf der Bewegungsförderung liegt, werden auch Effekte bezüglich der Reduktion nicht-aktiver Tätigkeiten aufgezeigt. Diese Zusammenstellung soll die Entwicklung und Umsetzung weiterer Interventionsmaßnahmen zur Förderung eines gesunden und aktiven Lebensstils unterstützen.

Schlüsselwörter: Gesundheitsverhalten, Sport, Übergewicht, Adipositas.

INTRODUCTION

There is strong evidence for the association between physical inactivity and major non-communicable diseases such as coronary heart disease, type 2 diabetes and certain types of cancer (32). Worldwide, an estimated 60% of the population are currently at risk for non-communicable diseases due to a lack of physical activity (PA) (63) and roughly 1.9 million deaths per year are attributable to insufficient PA (62). Particularly children and adolescents are displaying low levels of PA (5), which has been linked to the increasing prevalence of overweight and obesity in youth. A distinct decline in PA is observed with school entry (54) and at this age the most pronounced increase in the prevalence of overweight and obesity

SUMMARY

Insufficient physical activity is associated with an increased burden for non-communicable diseases and changes in concepts of illness and health for modern developed societies. Particularly during childhood and adolescence a pronounced decline in physical activity can be observed, which necessitates an early promotion of an active lifestyle. Numerous intervention programs, involving environmental facilitation as well as education and/or motivation to promote physical activity in youth have been implemented. Schools are a popular setting due to the fact that a large population can be reached over a prolonged period of time. Nevertheless, the family needs to be incorporated as parents influence children's behaviour as well. Further, community engagement can provide valuable support. In general, multi-component "ecological" approaches that allow for a prolonged engagement with the intervention have shown the most promising results regarding sustainable effects on behaviour change. The purpose of this review is to provide an overview of these strategies by addressing important and ground-breaking studies and literature. Community-, family-, and school-based intervention breaking strategies that include environmental changes to facilitate physical activity as well as educational approaches are addressed including information on the efficacy and sustainability of specific programs. While strategies to promote physical activity are the major aspect of this review, effects on sedentary behaviours will be addressed as well. Such information is crucial as the promotion of an active lifestyle is a major component for future public health.

Key Words: Health, exercise, children, adolescents, overweight, multicomponent-interventions.

has been observed (24). In addition to benefits regarding weight management, risk reduction on non-communicable diseases and personal well-being (43), PA has been associated with cognitive development and academic achievement (30), which further underlines the importance of promoting PA at young ages. It has also been argued that children are more responsive to PA promotion programs, which would increase the likelihood of a lifelong sustain-

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nable change in health behaviour to achieve an active lifestyle (39). Various organisations have called for health promotion programs and strategies to promote PA in children and adolescents (58). In general, education-based approaches or environmental changes that facilitate PA have been utilized. Schools are the most commonly used setting for PA interventions, but successful intervention strategies need to include the family as well as the community, particularly regarding sustainability of intervention effects. Many programs, therefore, use a multi-component approach, which is based in schools but fosters engagement of parents and the community via different strategies. Several extensive reviews have evaluated the efficacy of intervention programs targeting physical activity in children in various settings (4, 12, 23, 28, 35, 56, 58) and a recent Cochrane review (61) addressed the importance of physical activity on obesity prevention. The focus of this review is to provide an overview of different strategies for the promotion of PA, independent of obesity prevention. Studies that predominantly focused on obesity intervention, therefore, were not included. Rather, a selection of specific PA promotion programs that have already been evaluated will be discussed in order to facilitate the decision-making process on future intervention programs to increase PA in youth. Figure 1 shows the structural framework used to organize different strategies utilized to promote PA. Many programs also rely on more than one of the discussed approaches and are, therefore, referred to as multi-component intervention.

PHYSICAL ACTIVITY PROMOTION WITHIN THE COMMUNITY AND FAMILY

Changes to the built environment that facilitate PA are one possibility to promote an active lifestyle at the community level. Commonly used strategies are the expansion of bike trails and bike lanes as well as sidewalks with safe road crossings close to schools.

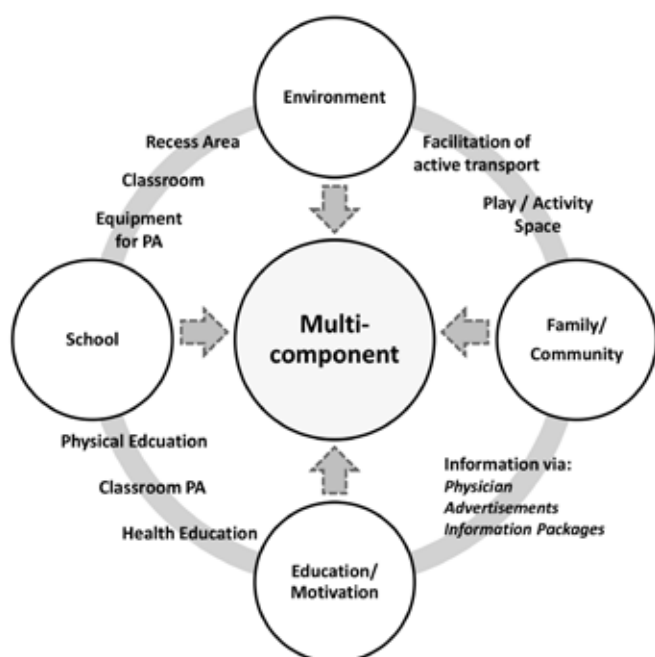


Figure 1: Structural framework for different intervention strategies

The safe routes to school program examined such an approach in 10 schools in California. Having access to sidewalks, bike lanes, and safe road crossings within a radius of 500m from the school showed a significant increase in active school commute (7). As an active commute to school has been shown to contribute substantially to children's PA (40, 55) such methods have a strong potential to increase overall PA. Another environmental approach to promote after-school PA is the facilitation of access to spaces for free play and Farley et al. showed a significant increase in children's PA with access to supervised playgrounds (18).

Rather than relying on environmental changes there is the opportunity to provide education and motivation for an active and healthy lifestyle in different settings. Black et al., for example, showed that supporting adolescents with goal setting regarding a healthy lifestyle can contribute to an increase in PA levels accompanied by a reduction in body weight (6). The increase in PA, however, could not be sustained beyond the intervention period, even though sustainable effects on body weight were observed. Despite a lack of effect on PA, peer-group interventions, focusing on a more active lifestyle, were effective in reducing sedentary behaviours (26, 47), which is independently associated with chronic disease risk (16). Nevertheless, the promotion of PA remains the primary focus of this review. An increase in PA along with changes in dietary behaviour and media consumption was observed with a computer-based evaluation of current health-behaviour along with monthly consultations with the primary care physician and mailed information on behaviour change (42). Overall, evidence on education-based programs at the community level is inconsistent but van Sluijs et al. argue that there is no obvious reason why community-based programs should not be effective in the promotion of PA (58). Particularly in children family engagement may be a crucial aspect to obtain sustainable effects, as parents influence their children's health behaviour. Education and motivation at the family level, however, did not provide clear evidence regarding changes in PA either (10, 25, 50). Even though shared exercise of parents and children potentially increases PA, no sustainable effects beyond the intervention period could be shown (36, 45). The inefficiency of these strategies has, at least partially, been explained by the short intervention time of only 3 months. A duration of at least one year or repeated intervention efforts have been suggested in order to achieve long-term behaviour change (28, 57). School-based intervention programs, therefore, have become popular as the school setting allows for an engagement with the intervention over several years. Further, the majority of children and adolescents can be reached independent of their family background.

PHYSICAL ACTIVITY PROMOTION IN THE SCHOOL-SETTING

As was shown for community-based interventions, school-based interventions have utilized environmental changes as well as education and motivation to promote PA. Similar to community-based interventions an increase in PA was observed with access to a gym or when equipment and safe space for play was made available during recess (46, 52, 60). The availability of space and small equipment for PA during recess did increase PA even when children had the choice between being active or sedentary (46). These results support the argument of an inherent desire of children to be active (48). Further, changes in the classroom environment could affect

children's PA positively. In a pilot study Lanningham-Foster et al. created an activity permissive classroom environment in a storage facility that resembled a small village (31). Using notebooks and mobile blackboards along with standing desks, children were allowed to move freely throughout this so called "neighbourhood". Despite the positive results on PA during the two week intervention period the authors did acknowledge that such a project may not be feasible on a large scale. A more feasible approach would be the utilization of standing desks in a regular classroom, which did result in a reduction in sedentary behaviour but did not affect PA. Projects like "the neighbourhood" may also serve as inspiration for ideas regarding changes in the classroom environment to foster PA during school time.

Physical Education (PE) is another aspect, where school-based promotion of PA could take place. The incorporation of daily PE has become a popular topic and several programs have implemented daily PE lessons that were supervised by the PE as well as the classroom teacher (29,51). Despite positive effects of daily PE on PA, fitness and body composition it remains difficult to convince policy makers to implement daily PE in the general school system. Fairclough and Stratton, therefore, suggest to put more emphasis on activity time during PE, independent of the question of daily PE or not (17). The effect of increased activity time during PE on children's daily PA, however, remains to be determined. An increased participation in out-of-school PA may be facilitated by increased physical fitness, which was shown as a result of more PE (29). Such a change in leisure time PA may also be achieved by educational approaches during PE that emphasize the benefits of PA after school. The program „(S)Partners for Heart Health“ utilizes a special curriculum, which promotes PA during school-time as well as after school (9). In addition, school-children were given the opportunity to communicate with exercise science students via internet to assist with individual goal-setting and strategies to overcome barriers for an active lifestyle and a healthy diet.

Due to the limited time in PE, information, motivation, and education for an active lifestyle should also occur during classroom education. Further, short active breaks in the classroom are commonly used to support the theoretical information on benefits of PA (3,21,34,41). Even though these short breaks may not have a huge impact on daily PA time, they could serve as examples for active choices in the home environment, which would result in a reduction in sedentary time and could potentially contribute to increased overall PA if performed regularly after school. In addition to the effect on sedentary time and possibly PA, active breaks have been shown to increase attention and cognitive performance (13,34). Despite the implementation of various school-based programs to promote PA, evidence on the effects on total daily PA and particularly the transferability beyond the school setting remains inconclusive (28). Especially in younger children, the family environment needs to be considered as parents influence their offspring's lifestyle and dietary behaviour. Several PA promotion programs try to include the parents into the intervention. Information and education materials are predominantly used to engage parents in the program, but homework for the entire family and teacher-parent meetings may further facilitate parental engagement. As these programs rely on different strategies to promote PA, such approaches are referred to as multi-component intervention programs.

MULTI-COMPONENT STRATEGIES TO PROMOTE PHYSICAL ACTIVITY IN YOUTH

School-based multi-component strategies, including the family, have been shown to be more successful in increasing PA levels in children compared to programs that rely on a single strategy only (11,28,53). One example for a socio-economical, multi-component approach is the program „Join the Healthy Boat – Primary School“, which has been implemented throughout the state of Baden-Württemberg in southwest Germany. The intervention mapping protocol (IMP) (2) was used as a theoretical framework for the program development. The IMP is a problem- and theory-driven protocol that was especially developed to guide the design of evidence-based intervention programs. The protocol describes the interactive process of a health promotion program development in six steps: needs assessment; the identification of outcomes and change objectives; the selection of theory based methods and practical strategies; the program development; generation of adoption and implementation plan; and the evaluation (1). Based on these six steps of the IMP the intervention specifically addresses a promotion of PA along with a reduction in media consumption and sugar-sweetened beverages.

Providing active and healthy choices is a key aspect of the program that is predominantly implemented by the classroom teacher. In addition to flexibility on program implementation and higher acceptance in the teaching community, the utilization of classroom teachers, rather than external experts, allows for a cost-effective and, therefore, sustainable implementation of the intervention over a prolonged period of time. Interested teachers are trained in a series of 3 workshops by experienced colleagues who have undergone extensive training in the implementation of the program. These so-called consulting teachers also provide additional support beyond the workshop series if needed and are engaged in the future development of the intervention program. Teaching materials have been developed by an interdisciplinary team of scientists in collaboration with experienced primary school teachers in accordance with the current primary school curriculum and consist of 20 lesson plans each for grades 1 through 4. All materials can be directly applied in a classroom setting. In addition, there are 56 activity cards with short exercises that can be performed in the classroom. Teachers are asked to provide two active breaks per day, lasting 5 to 7 minutes, during their lessons. In grades 3 and 4 there are additional index cards, which provide exercises that can be performed by the children during breaks or recess. These exercises may also serve as active choices for after-school activities. Parental involvement is facilitated by six family homework assignments, which inform parents about the current health-related content taught in class and promote an active engagement of parents in their children's leisure activities. In addition, seven parent letters and materials for two parent-teacher meetings per school-year are provided.

The program is currently evaluated via a cluster-randomized study, including almost 2000 children in southwest Germany (14). A pilot study already showed positive effects on body fatness and waist-to-height ratio (8,7). The results also indicate a less pronounced age-related decline in PA, which has been shown previously in a similar intervention program implemented by external experts (59). The reliance on external experts, however, increases intervention costs, which hinders sustainability. It may also negatively affect acceptability of the program in the school faculty. In

addition to positive effects on PA, a teacher-implemented intervention focusing on motor abilities during PE increased physical fitness (22). The positive effects of multi-component interventions on fitness, PA and body fat percentage have already been reported in pre-school children (44), which could facilitate sports participation at a young age beyond the intervention and enhance the chances for an active lifestyle throughout childhood and adolescence, possibly into adulthood.

Other multi-component approaches emphasized community engagement in addition to the in-school intervention. Shared activities between schools and local fitness clubs (15) as well as information on the benefits of a healthy lifestyle via print media and local radio (19) are examples of a combination of school-based interventions and community involvement. A comprehensive program of PA promotion in children and adolescents is „Action Schools! BC“ (37). Even though, specific strategies are based on the needs of individual schools there are 6 aspects that should be addressed – school environment, PE, classroom action, family and community, extracurricular, and school spirit. Further, all participating schools are required to provide at least 2 PE lessons per week and ensure 15 minutes/day of PA via active breaks. While PA was significantly increased in 9- to 11-year-old boys there was no change in PA levels in girls (38). These results indicate that sex specific differences in the promotion of PA during childhood and adolescence need to be considered more strongly when designing and implementing programs to promote PA in youth.

SUMMARY AND FUTURE DIRECTIONS

Even though numerous intervention programs have been implemented to promote PA during childhood and adolescence there is currently only limited evidence on the efficacy of different approaches, particularly regarding long-term sustainability. More research, therefore, is needed to enhance the understanding regarding effective strategies to ensure sufficient PA as this is an important aspect in public health. Multi-component strategies seem to be the most promising approach (28). Changes in traditional classroom education and the implementation of active breaks along with accessibility of open spaces during recess and after school are important aspects in the promotion of PA (49). Intervention programs should also be implemented over a prolonged period of time in order to achieve sustainable changes in health behaviour (28,57). Along with the prolonged engagement in PA promotion, long-term evaluation of different intervention strategies, following participants beyond the intervention period, should be implemented. In addition, the evaluation should differentiate between direct outcomes, such as increased PA due to the engagement in specific exercise programs, and the transferability out of the specific intervention setting (4). Increasing the understanding of mediators of behaviour change may further contribute to the development of effective intervention strategies (33). Finally, compliance with different programs needs to be considered, as intervention programs can only be successful if the population is willing to participate. Easy access and low barriers for an engagement in an active lifestyle are, therefore, crucial components in health promotion. Differences in needs and preferences of the target population should be considered as well. In order to address the needs of diverse populations various levels of PA promotion have been suggested to enhance the chan-

ces for success. The Global Advocacy for Physical Activity (GAPA) and the Advocacy Council of the International Society for Physical Activity and Health (ISPAH) has summarized 7 best investments for PA (20):

- Regular PE and structural support for PA in schools
 - Promotion of active transportation
 - Development of safe spaces for PA
 - Integration of PA in the health care system
 - Information and education on benefits of PA via mass media
 - Community programs engaging the entire population in the promotion of PA
 - Establishment of sports programs that promote „sports for all“
- The necessity to promote PA, particularly in youth has been emphasized by various policy documents (58) but it remains to be seen whether sufficient efforts will be taken, particularly regarding the facilitation of PA in children and adolescents. This review provides an overview of different intervention strategies by discussing selected ground-braking programs that addressed the growing problems associated with insufficient PA. More research, however, is necessary to provide sound evidence on the efficacy of implemented programs, which would convince the society to invest in programs that contribute to sufficient PA in children and adolescents of various backgrounds and needs.

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Conflict of interest

The authors have no conflicts of interest.

REFERENCES

1. **BARTHOLOMEW L, PARCEL G, KOK G, GOTTLIEB N, FERNÁNDEZ M:** Planning health promotion programs; an Intervention Mapping approach. Jossey-Bass, San Francisco, CA, 2011.
2. **BARTHOLOMEW LK, PARCEL GS, KOK G:** Intervention mapping: a process for developing theory- and evidence-based health education programs. *Health Educ Behav* 25 (1998) 545-563. doi:10.1177/109019819802500502
3. **BAYNE-SMITH M, FARDY PS, AZZOLLINI A, MAGEL J, SCHMITZ KH, AGIN D:** Improvements in heart health behaviors and reduction in coronary artery disease risk factors in urban teenaged girls through a school-based intervention: the PATH program. *Am J Public Health* 94 (2004) 1538-1543. doi:10.2105/AJPH.94.9.1538
4. **BEETS MW, BEIGHLE A, ERWIN HE, HUBERTY JL:** After-school program impact on physical activity and fitness: a meta-analysis. *Am J Prev Med* 36 (2009) 527-537. doi:10.1016/j.amepre.2009.01.033
5. **BIDDLE SJ, GORELY T, MARSHALL SJ, MURDEY I, CAMERON N:** Physical activity and sedentary behaviours in youth: issues and controversies. *J R Soc Promot Health* 124 (2004) 29-33. doi:10.1177/146642400312400110
6. **BLACK MM, HAGER ER, LE K, ANLIKER J, ARTEAGA SS, DICLEMENTE C, GITTELSON J, MAGDER L, PAPAS M, SNITKER S, TREUTH MS, WANG Y:** Challenge! Health promotion/obesity prevention mentorship model among urban, black adolescents. *Pediatrics* 126 (2010) 280-288. doi:10.1542/peds.2009-1832

7. **BOARNET MG, ANDERSON CL, DAY K, McMILLAN T, ALFONZO M:** Evaluation of the California Safe Routes to School legislation: urban form changes and children's active transportation to school. *Am J Prev Med* 28 (2005) 134-140. doi:10.1016/j.amepre.2004.10.026
8. **BRANDSTETTER S, KLENK J, BERG S, GALM C, FRITZ M, PETER R, PROKOPCHUK D, STEINER RP, WARTHA O, STEINACKER J, WABITSCH M:** Overweight prevention implemented by primary school teachers: a randomised controlled trial. *Obes Facts* 5 (2012) 1-11. doi:10.1159/000336255
9. **CARLSON JJ, EISENMANN JC, PFEIFFER KA, JAGER KB, SEHNERT ST, YEE KE, KLAVINSKI RA, FELTZ DL:** (S)Partners for Heart Health: a school-based program for enhancing physical activity and nutrition to promote cardiovascular health in 5th grade students. *BMC Public Health* 8 (2008) 420. doi:10.1186/1471-2458-8-420
10. **COOKSON S, HEATH A, BERTRAND L:** The HeartSmart Family Fun Pack: an evaluation of family-based intervention for cardiovascular risk reduction in children. *Can J Public Health* 91 (2000) 256-259.
11. **DE BOURDEAUDHUIJ I, VAN CAUWENBERGHE E, SPITTAELS H, OPPERT JM, ROSTAMI C, BRUG J, VAN LENTHE F, LOBSTEIN T, MAES L:** School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project. *Obes Rev* 12 (2011) 205-216. doi:10.1111/j.1467-789X.2009.00711.x
12. **DOBBINS M, DE CORBY K, ROBESON P, HUSSON H, TIRILIS D:** School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6-18. *Cochrane Database Syst Rev* (2009) CD007651.
13. **DONNELLY JE, LAMBOURNE K:** Classroom-based physical activity, cognition, and academic achievement. *Prev Med* 52 (2011) 36-42. doi:10.1016/j.jpmed.2011.01.021
14. **DREYHAUPT J, KOCH B, WIRT T, SCHREIBER A, BRANDSTETTER S, KESZTYUES D, WARTHA O, KOBEL S, KETTNER S, PROKOPCHUK D, HUNSDOERFER V, KLEPSCH M, WIEDOM M, SUFEIDA S, FISCHBACH N, MUCHE R, SEUFERT T, STEINACKER JM:** Evaluation of a health promotion program in children: Study protocol and design of the cluster-randomized Baden-Wuerttemberg primary school study [DRKS-ID: DRKS0000494]. *BMC Public Health* 12 (2012) 157. doi:10.1186/1471-2458-12-157
15. **EISENMANN JC, ALAIMO K, PFEIFFER K, PAEK HJ, CARLSON JJ, HAYES H, THOMPSON T, KELLEHER D, OH HJ, ORTH J, RANDALL S, MAYFIELD K, HOLMES D. PROJECT FIT:** Rationale, design and baseline characteristics of a school- and community-based intervention to address physical activity and healthy eating among low-income elementary school children. *BMC Public Health* 11 (2011) 607. doi:10.1186/1471-2458-11-607
16. **EKELUND U, BRAGE S, FROBERG K, HARRO M, ANDERSSON SA, SARDINHA LB, RIDDOCH C, ANDERSEN LB:** TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS Med* 3 (2006) e488. doi:10.1371/journal.pmed.0030488
17. **FAIRCLOUGH S, STRATTON G:** Improving health-enhancing physical activity in girls' physical education. *Health Educ Res* 20 (2005) 448-457. doi:10.1093/her/cyg137
18. **FARLEY TA, MERIWETHER RA, BAKER ET, WATKINS LT, JOHNSON CC, WEBBER LS:** Safe play spaces to promote physical activity in inner-city children: results from a pilot study of an environmental intervention. *Am J Public Health* 97 (2007) 1625-1631. doi:10.2105/AJPH.2006.092692
19. **GENTILE DA, WELK G, EISENMANN JC, REIMER RA, WALSH DA, RUSSELL DW, CALLAHAN R, WALSH M, STRICKLAND S, FRITZ K:** Evaluation of a multiple ecological level child obesity prevention program: Switch what you Do, View, and Chew. *BMC Med* 7 (2009) 49. doi:10.1186/1741-7015-7-49
20. **GLOBAL ADVOCACY FOR PHYSICAL ACTIVITY (GAPA), THE ADVOCACY COUNCIL OF THE INTERNATIONAL SOCIETY FOR PHYSICAL ACTIVITY AND HEALTH (ISPAH):** NCD Prevention: Investments that work for Physical Activity. *Br J Sports Med* 46 (2012) 709-712.
21. **GRAF C.** Das CHILT Projekt. *Dtsch Z Sportmed* 54 (2003) 247.
22. **GRAF C, KOCH B, FALKOWSKI G, JOUCK S, CHRIST H, STAUDENMAIER K, TOKARSKI W, GERBER A, PREDEL HG, DORDEL S:** SCHOOL-BASED PREVENTION: EFFECTS ON OBESITY AND PHYSICAL PERFORMANCE AFTER 4 YEARS. *J Sports Sci* 26 (2008) 987-994. doi:10.1080/02640410801930176
23. **HEATH GW, PARRA DC, SARMIENTO OL, ANDERSEN LB, OWEN N, GOENKA S, MONTES F, BROWNSON RC, LANCET PHYSICAL ACTIVITY SERIES WORKING GROUP:** Evidence-based intervention in physical activity: lessons from around the world. *Lancet* 380 (2012) 272-281. doi:10.1016/S0140-6736(12)60816-2
24. **HOFFMANN SW, ROLF U, PERIKLES S:** Refined analysis of the critical age ranges of childhood overweight: implications for primary prevention. *Obesity* 20 (2012) 2151-2154. doi:10.1038/oby.2012.172
25. **HOVELL MF, NICHOLS JE, IRVIN VL, SCHMITZ KE, ROCK CL, HOFSTETTER CR, KEATING K, STARK LJ:** Parent/Child training to increase pre-teens' calcium, physical activity, and bone density: a controlled trial. *Am J Health Promot* 24 (2009) 118-128. doi:10.4278/ajhp.08021111
26. **JAGO R, BARANOWSKI T, BARANOWSKI JC, THOMPSON D, CULLEN KW, WATSON K, LIU Y:** Fit for Life Boy Scout badge: outcome evaluation of a troop and Internet intervention. *Prev Med* 42 (2006) 181-187. doi:10.1016/j.jpmed.2005.12.010
27. **KESZTYÜS D, SCHREIBER A, WIRT T, WIEDOM M, DREYHAUPT J, BRANDSTETTER S, KOCH B, WARTHA O, MUCHE R, WABITSCH M, KILIAN R, STEINACKER JM:** Economic evaluation of URMELE-ICE, a school-based overweight prevention programme comprising metabolism, exercise and lifestyle intervention in children. *Eur J Health Econ* 14 (2013) 185-195. doi:10.1007/s10198-011-0358-3
28. **KRIEMLER S, MEYER U, MARTIN E, VAN SLUIJS EM, ANDERSEN LB, MARTIN BW:** Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. *Br J Sports Med* 45 (2011) 923-930. doi:10.1136/bjsports-2011-090186
29. **KRIEMLER S, ZAHNER L, SCHINDLER C, MEYER U, HARTMANN T, HEBESTREIT H, BRUNNER-LA ROCCA HP, VAN MECHELEN W, PUDER JJ:** Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: cluster randomised controlled trial. *BMJ* 340 (2010) c785. doi:10.1136/bmj.c785
30. **LAMBOURNE K, DONNELLY JE:** The role of physical activity in pediatric obesity. *Pediatr Clin North Am* 58 (2011) 1481-1491. doi:10.1016/j.pcl.2011.09.004
31. **LANNINGHAM-FOSTER L, FOSTER RC, MCCRADY SK, MANOHAR CU, JENSEN TB, MITRE NG, HILL JO, LEVINE JA:** Changing the school environment to increase physical activity in children. *Obesity (Silver Spring)* 16 (2008) 1849-1853. doi:10.1038/oby.2008.282
32. **LEE IM, SHIROMA EJ, LOBELO F, PUSKA P, BLAIR SN, KATZMARZYK PT, LANCET PHYSICAL ACTIVITY SERIES WORKING GROUP:** Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* 380 (2012) 219-229. doi:10.1016/S0140-6736(12)61031-9
33. **LUBANS D, MORGAN P:** Evaluation of an extra-curricular school sport programme promoting lifestyle and lifetime activity for adolescents. *J Sports Sci* 26 (2008) 519-529. doi:10.1080/02640410701624549
34. **MAHAR MT, MURPHY SK, ROWE DA, GOLDEN J, SHIELDS AT, RAEDEKE TD:** Effects of a classroom-based program on physical activity and on-task behavior. *Med Sci Sports Exerc* 38 (2006) 2086-2094. doi:10.1249/01.mss.0000235359.16685.a3
35. **METCALF B, HENLEY W, WILKIN T:** Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes (*EarlyBird* 54). *BMJ* 345 (2012) e5888. doi:10.1136/bmj.e5888
36. **MORGAN PJ, LUBANS DR, PLOTNIKOFF RC, CALLISTER R, BURROWS T, FLETCHER R, OKELY AD, YOUNG MD, MILLER A, CLAY V, LLOYD A, COLLINS CE:** The 'Healthy Dads, Healthy Kids' community effectiveness trial: study protocol of a community-based healthy lifestyle program for fathers and their children. *BMC Public Health* 11 (2011) 876. doi:10.1186/1471-2458-11-876
37. **NAYLOR PJ, MACDONALD HM, REED KE, MCKAY HA:** Action Schools! BC: a socioecological approach to modifying chronic disease risk factors in elementary school children. *Prev Chronic Dis* 3 (2006) A60.
38. **NAYLOR PJ, MACDONALD HM, WARBURTON DE, REED KE, MCKAY HA:** An active school model to promote physical activity in elementary schools: action schools! BC. *Br J Sports Med* 42 (2008) 338-343. doi:10.1136/bjsm.2007.042036

39. NELSON M, NEUMARK-STZAINER H, SIRARD J: Longitudinal and secular trends in physical activity and sedentary behavior during adolescence. *Pediatrics* 118 (2006) e1627.
40. PABAYO R, MAXIMOVA K, SPENCE JC, PLOEG KV, WU B, AND VEUGELERS PJ: The importance of Active Transportation to and from school for daily physical activity among children. *Prev Med* 55 (2012) 196-200. doi:10.1016/j.ypmed.2012.06.008
41. PANGRAZI RP, BEIGHLE A, VEHIGE T, VACK C: Impact of Promoting Lifestyle Activity for Youth (PLAY) on children's physical activity. *J Sch Health* 73 (2003) 317-321. doi:10.1111/j.1746-1561.2003.tb06589.x
42. PATRICK K, CALFAS KJ, NORMAN GJ, ZABINSKI MF, SALLIS JF, RUPP J, COVIN J, CELLA J: Randomized controlled trial of a primary care and home-based intervention for physical activity and nutrition behaviors: PACE+ for adolescents. *Arch Pediatr Adolesc Med* 160 (2006) 128-136. doi:10.1001/archpedi.160.2.128
43. PENEDO FJ, DAHN JR: Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Curr Opin Psychiatry* 18 (2005) 189-193. doi:10.1097/00001504-200503000-00013
44. PUDEK JJ, MARQUES-VIDAL P, SCHINDLER C, ZAHNER L, NIEDERER I, BÜRGI F, EBENEGER V, NYDEGGER A, KRIEMLER S: Effect of multidimensional lifestyle intervention on fitness and adiposity in predominantly migrant preschool children (Ballabeina): cluster randomised controlled trial. *BMJ* 343 (2011) d6195. doi:10.1136/bmj.d6195
45. RANDELL LB, TAYLOR A, OAKLAND D, SCHMIDT J, MOYER-MILEUR L, SHULTZ B: Daughters and mothers exercising together: effects of home- and community-based programs. *Med Sci Sports Exerc* 35 (2003) 286-296. doi:10.1249/01.MSS.0000048836.67270.1F
46. RIDGERS ND, STRATTON G, FAIRCLOUGH SJ, TWISK JW: Long-term effects of a playground markings and physical structures on children's recess physical activity levels. *Prev Med* 44 (2007) 393-397. doi:10.1016/j.ypmed.2007.01.009
47. ROSENKRANZ RR, BEHRENS TK, DZEWALTOWSKI DA: A group-randomized controlled trial for health promotion in Girl Scouts: healthier troops in a SNAP (Scouting Nutrition & Activity Program). *BMC Public Health* 10 (2010) 81. doi:10.1186/1471-2458-10-81
48. ROWLAND TW: The biological basis of physical activity. *Med Sci Sports Exerc* 30 (1998) 392-399. doi:10.1097/00005768-199803000-00009
49. SALMON J: Novel strategies to promote children's physical activities and reduce sedentary behavior. *J Phys Act Health* 7 (2010) 299-306.
50. SHELTON D, LE GROS K, NORTON L, STANTON-COOK S, MORGAN J, MASTERMAN P: Randomised controlled trial: A parent-based group education programme for overweight children. *J Paediatr Child Health* 43 (2007) 799-805. doi:10.1111/j.1440-1754.2007.01150.x
51. SOLLERHED AC, EJLERTSSON G: Physical benefits of expanded physical education in primary school: findings from a 3-year intervention study in Sweden. *Scand J Med Sci Sports* 18 (2008) 102-107. doi:10.1111/j.1600-0838.2007.00636.x
52. STRATTON G, MULLAN E: The effect of multicolor playground markings on children's physical activity level during recess. *Prev Med* 41 (2005) 828-833. doi:10.1016/j.ypmed.2005.07.009
53. TIMPERIO A, SALMON J, BALL K: Evidence-based strategies to promote physical activity among children, adolescents and young adults: review and update. *J Sci Med Sport* 7 (2004) 20-29. doi:10.1016/S1440-2440(04)80274-3
54. TROST SG, PATE RR, SALLIS JF, FREEDSON PS, TAYLOR WC, DOWDA M, SIRARD J: Age and gender differences in objectively measured physical activity in youth. *Med Sci Sports Exerc* 34 (2002) 350-355. doi:10.1097/00005768-200202000-00025
55. TUDOR-LOCKE C, AINSWORTH BE, POPKIN BM: Active commuting to school: an overlooked source of children's physical activity? *Sports Med* 31 (2001) 309-313. doi:10.1136/bjsports-2011-090187
56. VAN SLUIJS EM, KRIEMLER S, MCMINN AM: The effect of community and family interventions on young people's physical activity levels: a review of reviews and updated systematic review. *Br J Sports Med* 45 (2011) 914-922. doi:10.1136/bjsports-2011-090187
57. VAN SLUIJS EM, AND MCMINN A: Preventing obesity in primary school-children. *BMJ* 340 (2010) c819. doi:10.1136/bmj.c819
58. VAN SLUIJS EM, MCMINN AM, GRIFFIN SJ: Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *BMJ* 335 (2007) 703. doi:10.1136/bmj.39320.843947.BE
59. VERSTRAETE SJ, CARDON GM, DE CLERCQ DL, DE BOURDEAUDHUIJ IM: A comprehensive physical activity promotion programme at elementary school: the effects on physical activity, physical fitness and psychosocial correlates of physical activity. *Public Health Nutr* 10 (2007) 477-484. doi:10.1017/S1368980007223900
60. VERSTRAETE SJ, CARDON GM, DE CLERCQ DL, DE BOURDEAUDHUIJ IM: Increasing children's physical activity levels during recess periods in elementary schools: the effects of providing game equipment. *Eur J Public Health* 16 (2006) 415-419.
61. WATERS E, DE SILVA-SANIGORSKI A, HALL BJ, BROWN T, CAMPBELL KJ, GAO Y, ARMSTRONG R, PROSSER L, SUMMERBELL CD: Interventions for preventing obesity in children. *Cochrane Database Syst Rev* (2011) CD001871.
62. WORLD HEALTH ORGANISATION: Global Strategy on Diet, Physical Activity and Health. World Health Organization Press, Geneva, 2004.
63. WORLD HEALTH ORGANISATION: The world health report 2002. World Health Organization Press, Geneva, 2002.

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