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Advisory report Lekker Fit

Improving the mental and physical health of Rotterdam youth

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Table of Contents

Advisory report Lekker Fit: Summary

Objective: This document provides advice on health behaviours contributing to a higher risk of obesity and overweight in children and adolescents, as well as to youth well-being. The changeable determinants of these health behaviours are investigated, as well as which strategies can be most effectively used in a large-scale intervention to modify these determinants and reduce overweight and obesity rates among children and adolescents. We provide brief advice on how to tailor the intervention according to the needs of participants, and on which modes of intervention delivery are most promising.

Method: We conducted systematic searches of relevant research studies in key databases, such as WebofScience, MEDLINE and Google Scholar, but did not carry out a full systematic review.

Results: Findings from the literature indicate that several health behaviours largely influence adolescent's risks of obesity and overweight, as well as their mental health and well-being. Research has shown that targeting behaviours such as sleep, sedentary behaviour, physical activity and diet, can have a robust impact on adolescent's mental and physical health. To develop effective behaviour change interventions, it is essential to identify and target the most relevant and changeable determinants of the target health behaviours in this population.

Determinants of health behaviours can be categorized as environmental or psychosocial determinants. Environmental determinants differ per health behaviour, but generally relate to how easy or difficult it is for the adolescent to engage in the desired behaviour. For example, accessibility to parks or sports facilities provide adolescents with more opportunities to engage in physical activity and are typically associated with higher levels of physical activity in adolescents. Environmental determinants are therefore a promising target for behaviour change interventions. In support of that premise, several healthy eating interventions found that changes to the physical environment of school canteen's led to significant improvements to adolescent's eating habits (Broers, De Breucker, Van den Broucke, & Luminet, 2017). Psychosocial determinants include motivational determinants that influence whether or not an individual is motivated to change their behaviour, and self-regulatory factors, which influence whether an individual will be able to direct their behaviour in service of their motivation and long-term goals.

Research has shown that more effective interventions typically target multiple determinants of health behaviours, including both motivational and self-regulation factors. Additionally, more effective behaviour change interventions also tend to utilize multiple strategies to influence these determinants, and to tailor the components of the intervention to the needs of participants. For example, motivational strategies are more appropriate for individuals that are not yet ready or motivated to change, but are rather ineffective for individuals who are motivated to change, but lack the tools and capacity to initiate and maintain the desired behaviour change. Conversely, strategies that help individuals self-regulate their behaviour are particularly effective for individuals who are already motivated, but are rather ineffective for individuals who are not motivated to change. This is an example of how the application of intervention components must be tailored to the psychosocial determinants of the individual, particularly to his or hers levels of motivation and readiness-to-change (Krebs et al., 2018; Sarkin et al., 2001). It may also be promising to tailor the interventions to participants' socio-economic status (SES), since that is a predictor of inequalities in health behaviours. This tailoring can be done, for instance, by targeting the most relevant determinants for behaviour change in low-SES participants (e.g. social support, self-efficacy), and by personalizing intervention components to address specific needs of this target group, such as their material circumstances (e.g. availability of healthy food at home, availability to sports and recreational facilities).

Finally, the setting and mode of delivery of the intervention can also influence its effectiveness, particularly regarding interventions for children and adolescents. For example, digital applications are promising platforms for the delivery of such tailored interventions, since they are cost-effective, scalable and can combine and tailor the use of several interactive components to enhance user experience and support skill development. Furthermore, dietary and physical activity interventions that involve parents are more likely to promote significant behaviour change in adolescents. Involving schools in the process of intervention development and implementation also seems to be a popular and promising strategy, since it facilitates contact with and recruitment of the target population (i.e. children and adolescents) and changes at the environmental and policy level can be easily implemented.

Conclusions and implications: In conclusion, effective interventions to improve the mental health and reduce or prevent overweight and obesity in children and adolescents should focus on promoting physical activity and healthy eating in this population. With regards to improving mental health, interventions to improve the sleep of adolescents are also promising strategies. Furthermore, to promote behavioural change, it is crucial to target multiple psychological, social and environmental determinants of PA and dietary behaviours, as well as to tailor intervention components to the participant's needs. With regards to psychological determinants, it is important to address motivational constructs first. Subsequently, it is also important for interventions to incorporate strategies to improve the self-regulation of adolescents, helping them to translate their motivations into action. Digital applications are promising precisely because they can facilitate the tailoring of intervention components to participant's needs, besides being cost-effective and easily scalable. With regards to intervention setting, interventions to reduce or prevent overweight and obesity in children and adolescents should consider involving participant's parents and other community members. School involvement also seems to be beneficial and several school-based interventions have been shown to effectively influence health behaviours in adolescents.

The advice below contains additional information on the influence of health behaviours on the mental and physical health of adolescents, and the characteristics of effective behavioural change interventions. Further details are provided on the determinants of health behaviours in adolescents and the techniques used to influence them, as well as on the influence of various intervention setting, and on how to tailor the components of behavioural change interventions to the needs of this population. Additionally, take home messages and examples of successful behavioural change interventions are provided.

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Objective

This document provides advice on health behaviours contributing to a higher risk of obesity and overweight in children and adolescents, as well as to youth well-being. The changeable determinants of these health behaviours are investigated, as well as which strategies can be most effectively used in a large-scale intervention to modify these determinants and reduce overweight and obesity rates among children and adolescents. We provide brief advice on how to tailor the intervention according to the needs of participants, and on which modes of intervention delivery are most promising.

The influence of behaviour on youth mental and physical health.

Behavioural causes of youth overweight and obesity

In de basis wordt gewichtstoename veroorzaakt door een disbalans in energie- inname en energieverbruik van het lichaam. Naast overmatige voeding is een sedentaire levensstijl een logische oorzaak van een disbalans tussen energie-inname en -verbruik. Een toename van verstedelijking en sedentariteit heeft een vermindering van de fysieke activiteit tot gevolg (WHO, 2017). De Baere et al. stelt dat sedentariteit toeneemt met de leeftijd: het activiteitsniveau daalt gedurende de kindertijd en de adolescentie. Een aantal sleutelmomenten hebben een belangrijke invloed, waaronder de overgang van lagere naar middelbare school. Ook stellen zij dat gedurende de dag, verschillende aspecten van PA en SB met elkaar in competitie gaan, vooral op het moment vlak na schooltijd.

Behavioural factors influencing youth well-being

Generally speaking, living a healthy lifestyle is well established to be linked to well-being, both in youth and in adults. Physical activity (PA), sedentary behaviour (SB), sleep and dietary habits have all been associated with higher well-being and reduced mental health problems (Conry et al., 2011; Khalid, Williams, & Reynolds, 2017; Ussher, Owen, Cook, & Whincup, 2007).

Identifying changeable health behaviours to improve youth mental and physical health

Color labels: **-Most important** **- Promising** **- Troublesome/Ineffective**

Diet

To prevent and treat childhood and adolescent obesity interventions should aim to reduce childhood and adolescent consumption of refined carbohydrates, trans and saturated and energy dense foods. To that end, it may be useful to target the consumption of sweetened beverages and fast food (Ebbeling, Pawlak, & Ludwig, 2002). Furthermore, interventions addressing fruit and vegetable consumption (F&V consumption) have also been shown to be effective in preventing and reducing obesity in children and adolescents (Epstein et al., 2001). Sedentary behaviour, such as television viewing, has also been associated with worse dietary behaviour (Blanchette & Brug, 2005). Remarkably, increased consumption of sweetened beverages and fast food, as well as lower F&V consumption, have been linked to lower levels of well-being and increased symptoms of mental health problems, such as depression and anxiety (Conner et al., 2017; Khalid et al., 2017). Multiple psychosocial determinants of dietary behaviour have been identified (Kreausukon, Gellert, Lippke, & Schwarzer, 2011; Vereecken, Van Damme, & Maes, 2005), and will be discussed in the following section.

Physical activity and sedentary behaviour

A lifestyle characterized by lack of physical activity (PA) and excessive sedentary behaviour (SB) contributes to higher rates of obesity and overweight in youth. A systematic review on the prevalence of overweight and obesity in European children and adolescents found that levels of physical activity were lower and television viewing time were higher in overweight compared to healthy youth (Janssen et al., 2005; Tremblay et al., 2011). The effect of television viewing and screen time on obesity risk is thus of particular interest. Several systematic reviews have found significant relationships between SB and health indicators, as well as significant effects of interventions targeting adolescents SB on obesity measures (Sluijs, Mcminn, & Griffin, 2006). However, it is important to mention that recent systematic reviews failed to establish causality between SB and obesity, since results have been inconsistent, with some interventions targeting SB resulting in small or insignificant effects (Biddle, Bengoechea, & Wiesner, 2017). Nonetheless, SB such as prolonged screen time is likely to influence overweight by displacing more vigorous activities, as well as affecting diet (Blanchette & Brug, 2005). Moreover, both PA and SB have also been shown to be associated with mental health in children and adolescents. Low levels of PA and high levels of SB have been linked to lower well-being (Ussher et al., 2007), as well as to higher levels of anxiety, stress and depression in youth (Biddle & Asare, 2011). Therefore, improving levels of PA and reducing SB in children and adolescents is a promising strategy to reduce and prevent overweight and obesity, as well as to increase the well-being and reduce and prevent mental health problems in youth. Multiple psychosocial determinants of PA and SB have been identified and will be discussed in the following section.

Sleep

Sleep seems to play a role in obesity and overweight in youth. Sleep problems contribute to increased appetite, lower metabolic rates (i.e. less energy spent), and impairments in glucose metabolism, which leads to accumulation of fat tissue, less muscle mass (Knutson, Spiegel, Penev, & Van Cauter, 2007). Sleep problems are associated with higher rates of obesity and diabetes. Overall, longer sleep duration in youth was associated with lower adiposity indicators, as well as with better emotional regulation, better academic achievement, and better quality of life/well-being (Chaput et al., 2016). Another

meta-analysis showed that youth sleeping for short durations had twice the risk of overweight and obesity compared to those sleeping long durations. Thus, besides the well-established relationship between sleep and mental health, sleep may also be a promising behaviour to target in order to tackle overweight in adolescents.

However, it is important to mention that most interventions aiming to prevent or reduce obesity have not targeted sleep, thus there is a lack of evidence of the effect of such approaches to prevent and reduce paediatric obesity. Moreover, the evidence of a relationship between sleep and obesity comes from epidemiological studies, and there is yet a need for experimental studies to clarify whether sleep duration is indeed a risk factor for obesity. Some reviews have argued that the evidence base is not yet strong enough to give public health advice to the general population or specific groups about sleep duration being a modifiable risk factor for obesity (Marshall, Glozier, & Grunstein, 2008). Kinderen en jongeren die langer blootgesteld worden aan schermen, zoals televisie, mobiele telefoons, tablets, computer, spelcomputers, hebben vaker een kortere slaapduur en vaker last van slaapproblemen (Vlasblom, Sleuwen, Hoir & Beltman, 2017). Nonetheless, sleep is considered a promising target for behaviour change interventions to improve youth mental and physical health.

Determinants of PA and healthy eating

Psychosocial determinants

Theories of behaviour have identified various determinants as essential for the process of changing one's health behaviour. Several studies have investigated the importance of these psychological constructs in predicting health behaviour, such as PA and dietary behaviour, in the context of childhood and adolescence obesity. To change dietary and PA behaviour, a person needs to become motivated to do so, and they must translate their intentions into actual behaviour. Some of the most important personal determinants predicting PA and dietary behaviour were: Outcome expectancy, self-efficacy, social support, intentions, self-regulation and environmental opportunities for behaviour (Cerin, Barnett, & Baranowski, 2009; Schwarzer, 2008). Outcome expectancy and self-efficacy, for instance, are critical motivational determinants, and are direct precursors of intentions to change one's behaviour. Self-regulation, on the other hand, is essential in helping translate those intentions into action. Self-regulation refers to an individuals' capacity to regulate their own behaviour, and involves the self-control to strive towards one's goal and the use of planning strategies.

Outcome expectancy has been related to PA and dietary behaviour in obese adolescents (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003; Trost, Kerr, Ward, & Pate, 2001), and refers to the expected positive and negative consequences of a behaviour (e.g "I will feel better after PA"). Social support and social norms have also been shown to influence levels of PA and dietary behaviour in overweight adolescents (Baker, Little, & Brownell, 2003). Moreover, research has found that obese children and adolescents report significantly lower levels of self-efficacy than their healthy peers (Trost, Kerr, Ward, & Pate, 2001). Self-efficacy, namely someone's beliefs in their ability to succeed on a certain task, has been consistently identified as one of the most critical determinants of behaviour change (Schwarzer, 2008). Self-efficacy also relates to a person's beliefs in their capacity to deal with barriers for maintaining the behaviour change on the long term. Furthermore, greater self-regulation and the implementation of planning strategies has also been shown to be associated with less sedentary behaviour, greater fruit and vegetable consumption and engagement with PA in adolescents (Wills, Isasi, Mendoza, & Ainette, 2007).

Eetgedrag is veel minder beredeneerd dan aanvankelijk werd gedacht. Routines en gewoontes bepalen grotendeels wat we eten: we eten wat we eten omdat we dat altijd zo doen. Gedrag raakt ingesleten en een bepaalde context ontlokt automatisch een reactie, zonder dat daar uitgebreide deliberatie aan te pas komt. Ook al hebben mensen intenties tot gedragsverandering, gewoontegedrag laat zich maar lastig doorbreken. Ook voedingsgedrag dat niet voortkomt uit gewoonte, kan zonder veel beredenering op een automatische manier ontlokt worden door de sociale en fysieke context. (de Vet, 2019)

Environmental determinants

Besides personal psychological constructs, environmental availability of opportunities for the behaviour (e.g. availability of fruits and vegetables or of PA facilities) was also an important determinant of health behaviours in children and adolescents (Blanchette & Brug, 2005; Vereecken, Van Damme, & Maes, 2005). Thus, to promote PA and healthy dietary behaviour in children and adolescents, interventions should attempt to not only influence relevant determinants of motivation and self-regulation, but also to modify the environment to facilitate behaviour change.

Determinants of sleep duration and quality

Psychosocial determinants

Similarly to other health behaviours, psychosocial factors such as outcome expectancy, self-efficacy and self-regulation capacities also influence sleeping behaviour. Sleeping behaviour has also been associated with emotional lability and stress, although it is likely that this is a reciprocal causal relationship (i.e. more stress leads to less sleep, but less sleep also leads to more stress) (Ly, Mcgrath, & Gouin, 2015; Nixon, Thompson, Han, Becroft, & Clark, 2008). Finally, a person's habits and routines have a major impact on one's sleeping patterns. For instance, high frequency of mobile phone use has been identified as a risk factor for sleep disturbances (Hale & Guan, 2015). Moreover, some of the main components of interventions to improve sleep quality and duration, often referred to as sleep hygiene, focus on addressing a person's routines and habits before sleep. Commonly addressed topics include the restriction of liquid consumption before bed, restricting caffeine and alcohol, restriction of non-sleep related activities in bed, dealing with emotions before bed and establishing a regular sleep routine. A person's habits and behaviours before going to bed are promising targets of sleep interventions (Tan et al., 2012).

Environmental determinants

Several environmental factors influence youth sleep duration and quality. For example, both temperature and environmental noise have been related with sleep disturbances (Stepanski & Wyatt, 2003; Tan, Healey, Gray, & Galland, 2012). Light exposure in the morning/evening has been proven to advance/delay the circadian phase (Lack & Wright, 2007), thus sleep hygiene guidelines suggest that, prior to sleeping hours, people should control their bedroom

temperature and limit noise and light exposure. Encouraging people to make changes to their sleeping environment can be effective in helping improve sleep quality and durations in youth. Remarkably, school starting time has also been shown to influence sleep duration, and has been highlighted as a very promising target of interventions at a policy-level (Tan et al., 2012). Interventions aiming to improve sleep in youth should attempt to address psychosocial and environmental determinants of sleep quality and duration.

Evidence from eating and PA interventions to improve mental and physical health.

Overview

A systematic review of interventions to prevent overweight and obesity in children and adolescents found that most of the interventions targeting PA and dietary behaviour were effective (Doak, Visscher, Renders, & Seidell, 2006). PA in schools, reducing television viewing and reducing the consumption of carbonated beverages were some examples of effective interventions. Importantly, various studies in the systematic review found differences in intervention effects between genders and ethnic backgrounds, suggesting a need for further tailoring of interventions by relevant factors.

Whether studies addressed diet and PA or not may be less important than how those behaviours were targeted. Some interventions targeted these behaviours directly through school involvement (Doak, Visscher, Renders, & Seidell, 2006), or utilized multicomponent interventions targeting several important psychosocial determinants of those behaviours. Such approaches appear to be much more effective than single component interventions, such as education-based interventions (Van Sluijs, McMinn, & Griffin, 2007). A systematic review found strong evidence that school-based interventions with involvement of the family or community and multicomponent interventions can increase physical activity in adolescents (Sluijs et al., 2006). Another systematic review of dietary interventions on children aged 6-12 found that multi-component school-based interventions that combined classroom curriculum, parent and food service components showed the greatest promise for fruit and vegetable promotion among children (Blanchette & Brug, 2005). School programs promoting fruit and vegetables consumption and PA via multicomponent internet-based interventions also appeared to be promising. Taken together, the evidence from systematic reviews of interventions to promote healthy lifestyle in children and adolescents suggests that effective interventions should be of a multicomponent nature, targeting various psychological, social and environmental determinants, and taking into accounts the specific needs of the individual.

Targeting determinants: Psychosocial

For instance, targeting multiple psychological determinants, such as motivational constructs and self-regulation, seems promising in changing health behaviour. One intervention addressing self-efficacy and planning strategies of adolescents was shown to be more effective than knowledge-based interventions in fruit and vegetable intake (Kreausukon, Gellert, Lippke, & Schwarzer, 2011). Additionally, numerous studies have shown that interventions targeting both motivational determinants and self-regulatory factors, such as planning, have been shown to be effective in promoting PA than strictly motivational interventions (Milne, Orbell, & Sheeran, 2002; Sniehotta, Scholz, & Schwarzer, 2006).

Targeting determinants: Environmental

Additionally, at the environmental level, school-based interventions implementing changes in policy, such as changes in the school cantina's choice architecture (Arno & Thomas, 2016), subscription programs (Bere, Veierød, & Klepp, 2005), and curriculum-based changes (Jørgensen et al., 2017), have also been shown to be effective in promoting healthy dietary behaviour (French & Stables, 2003; Blanchette & Brug, 2005). Nudges, or choice architecture, are an effective way to guide children and adolescents towards healthier choices, such as more vegetables and fruit consumption, and away from unhealthy options, such as junk food. Particularly for those who are motivated to eat healthier, making healthy options in the school canteen more visible and attractive can increase the likelihood that these healthy alternatives are chosen. Thus, in addition to targeting psychosocial determinants of PA and dietary behaviour, multicomponent interventions could include strategic changes in the environment to influence behaviour.

Intervention Setting: Internet-based interventions (i.e. eHealth)

The use of digital applications to target socio-cognitive determinants has also received increased attention in the last decades, since it allows for the development of scalable, cost-effective, interactive interventions that can easily be computer-tailored to the participants. A systematic review of computer-tailored interventions on PA and dietary behaviour found evidence that they were quite successful in promoting behaviour change, and were particularly effective for fat reduction (Kroeze, Werkman, & Brug, 2006). Another review of digital interventions found support for intervention efficacy in improving physical activity, diet, or facilitating weight loss, particularly when interventions are more interactive and intensive, and when utilization rates are high (Norman et al., 2007). Such internet-based interventions have great potential, since they allow for the combination of motivational material and interactive self-regulation strategies, such as tailored plans, feedbacks and prompts.

For instance, an intervention with adolescents utilizing multi-media communication and tailored planning suggestions was effective at improving PA and dietary behaviour (Patrick et al., 2001). Another study found that providing self-monitoring tools (e.g. pedometers) helped sedentary adolescent girls improve their levels of PA (Schofield, Mummery, & Schofield, 2005). Such tools can be combined with tailored prompts and feedback delivered through multiple media channels (e.g. mobile). A recent meta-regression found evidence supporting the effectiveness of interventions combining self-monitoring with at least one other self-regulatory technique, such as prompting goal-setting and providing feedback (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Several other creative digital applications implementing motivational and self-regulatory strategies have emerged to promote behaviour change in children and adolescents. For example, gamification has been used to successfully promote the consumption of fruits and vegetables in adolescents by targeting social incentives (Jones, Madden, & Wengreen, 2014). Thus, there are many ways in which internet or mobile-based interventions can motivate adolescents to change their behaviour, such as helping them self-monitor and increasing the incentives to improve that behaviour. Several other strategies can additionally be implemented to help these individuals translate those motivations into action, such as planning strategies, and the use of tailored feedback and prompts.

Intervention Setting: Parental involvement

Besides school-based and internet-based interventions, several other approaches seem promising to deliver interventions aimed at preventing and reducing overweight and obesity in youth. For example, the role of parental involvement in preventing and reducing childhood and adolescence obesity can hardly be overstated (Ayoob, 2011; Golan & Crow, 2004). It has been well established that the physical, normative and social characteristics of the family influences the adoption and maintenance of health behaviour. The influence of family on the behaviour of children and adolescents may be particularly relevant, seeing as what adolescents eat, for instance, is largely dependent on what their family eats (Neumark-Sztainer, Wall, Perry, & Story, 2003). Family norms with regards to PA have also been shown to affect the PA behaviour of children and adolescents, an insight that should be considered when developing behavioural change interventions for this population. A randomized controlled trial found that a community-based intervention involving parents and children was more effective in promoting PA and reducing body-mass index than a control (Sacher et al., 2010). Moreover, a meta-analysis of family-based interventions targeting childhood obesity found evidence supporting their effectiveness for weight reduction (Berge & Everts, 2011). Importantly, how an intervention involves the parents seems to have an influence on intervention efficacy (for review see Hingle, O'Connor, Dave, & Baranowski, 2010). Studies that used direct methods (e.g. parent training sessions or family involvement in counselling) to engage parents were more likely to report positive or mixed results compared with those studies that used more indirect methods (e.g. telling youth to practice the behaviour at home). Additionally, those studies that used indirect methods to involve parents but required children engage their parent in an activity were also more likely to report positive or mixed results. Thus, it seems that an adequate level of parental involvement is critical to promote change of PA and dietary habits.

Intervention Design: Tailoring

When designing behavioural change interventions, it is important to adjust the content or materials to key characteristics of a target group. Tailored health messages are seen as more personally relevant to individuals, hence they attract more attention and are perceived more positively(Dijkstra, Hawkins, Kreuter, Resnicow, & Fishbein, 2011). More importantly, a meta-analysis of digital behaviour change interventions found that tailored digital interventions had significantly greater impacts on health outcomes than nontailored interventions. Thus, it is clearly important to tailor the intervention to the needs of the participants (Lustria et al., 2013).

One way to tailor interventions, is to adapt the intervention for high-risk individuals, as these individuals often reap the largest benefits from health promotion interventions (Mears & Jago, 2016). This can be done by selecting participants via a screening procedure and focusing prevention efforts on individuals most susceptible to future health problems (e.g. youth at risk of being overweight or obese). Alternatively, interventions can also be offered to the general public, but still apply tailoring by offering additional components specifically for individuals with risk-factors for future health problems.

Interventions can also be tailored according to demographic characteristics, such as gender. Reviews have found evidence that interventions focused on increasing moderate-to-vigorous physical activity seem to work more effectively in boys than in girls (Doak, Visscher, Renders, & Seidell, 2006; Mears & Jago, 2016). Alternatively, previous studies have found that females tend to be more health conscious, have more nutritional knowledge and apply that knowledge better than males (Doyal, 2001). Females are also more responsive to nutrition education and more susceptible of health information in general (Brug, Vandelanotte, & Bourdeaudhuij, 2004).

Additionally, the psychosocial determinants of behaviours can also differ depending on the individuals' characteristics. For instance, it has been shown that the motivational determinants for PA and for diet are different for woman and boys. Girls have been shown to have a higher consumption of F&V, which was mediated (i.e. driven by) by differences in psychosocial determinants of F&V consumption (Brug, Tak, Velde, Bere, & Bourdeaudhuij, 2008). Girls had significantly higher knowledge, self-efficacy, parental influence and accessibility to F&V, all of which are associated with increased F&V consumption. In the domain of PA, there are also significant gender differences in terms of the motivations for PA, specifically with regards to the perceived barriers and benefits of PA (i.e. outcome expectancy). For boys, the fun of physical exercise was a primary motivation for PA, whereas for girls improvements to their body image was a more important motivation(Butt, Weinberg, Breckon, & Claytor, 2011). Moreover, the behaviour change techniques used to target these determinants can also be tailored to a participants characteristics, as a study has found evidence that certain motivational techniques are better received by men than by woman (Vries, Truong, Zaga, Li, & Evers, 2017).

Finally, the structure of behavioural change interventions can be tailored to the participants needs by assessing psychosocial determinants. Motivational strategies are useful for those that have not yet set the goal to change their behaviour, but they are much less useful for people who are motivated to change but fail to implement their goals. Alternatively, strategies to improve self-regulation, such as planning and reminders, can be very effective for individuals who are motivated to change but struggle to translate their intentions into actions due to lack of self-regulatory capacity. However, such reminders and planning strategies are not useful for unmotivated individuals. As such, by assessing an individual's motivation, or their readiness-to-change, intervention components can be tailored to needs of the participants, which likely increases intervention effectiveness (Krebs, Norcross, Nicholson, & Prochaska, 2018).

Intervention Design: Tailoring for adolescents from low socioeconomic backgrounds

Interventions can also be tailored to individual's socio-demographic characteristics with regards to the behaviours they focus on, the behavioural techniques used, the mode of delivery and the intervention material. For instance, health inequalities in adults and in adolescents have been linked to socioeconomic status (SES). Children and adolescents of low SES typically engage in less PA and have lower F&V consumption than those of high SES (Leech, Mcnaughton, & Timperio, 2014). Hence, low SES can be considered a risk-factor for poor health behaviours. SES seems to drive health inequalities through differences in material (e.g. poverty), behavioural (e.g. less PA, more unhealthy eating) and psychosocial factors (e.g. lower social support). Thus, strategies for reducing health inequalities should focus on improving material circumstances in lower affluent groups, since improvements in material circumstances (i.e. availability of healthy food at home, poverty, family environment) directly and indirectly (via behavioural and psychosocial factors) contributes to reducing health inequalities in youth (Richter, Moor, & Lenthe, 2011).

Furthermore, tailoring intervention efforts on the basis of SES and tackling problematic behavioural and psychosocial factors in this target group may be beneficial. Recent research found that most of the discrepancy in levels of leisure PA between socioeconomic groups was explained by lower levels of social support and self-efficacy in low SES group (Cerin & Leslie, 2008). Remarkably, several studies investigating effective behaviour change interventions have found that low-SES groups can benefit from interventions enhancing self-efficacy and planning (i.e. self-regulatory skills) as much as those from high-SES (Hankonen, 2011; Hankonen, Absetz, Haukkala, & Uutela, 2009). Another study with adolescents from disadvantaged secondary schools found that a PA intervention targeting self-efficacy, social support and outcome expectancy was effective in promoting healthy weight loss (Lubans, Morgan, Aguiar, & Callister, 2011). Together, these results suggest that intervention with low-SES adolescents should focus on enhancing self-efficacy and social support for health behaviours, as well as on improving motivation by targeting outcome expectancies and on improving self-regulatory capacities through planning strategies.

Besides targeting the most essential psychosocial factors involved in behaviour change, when attempting to change health behaviours in people from low-SES, it is important to carefully consider the intervention approaches and techniques utilized. For instance, since the health literacy of the low-SES groups is more limited (Porr, Drummond, & Richter, 2006), techniques such as provision of health information might have SES-specific effects, but more research is needed to explore these differences (Hankonen, 2011). Although the evidence base for this population is very limited, a few reviews have investigated the effects of behavioural change techniques for low-SES groups (Everson-Hock et al., 2013; Michie, Jochelson, Markham, & Bridle, 2009), and for low-SES adolescents specifically (Kornet-van Der, Altenburg, Van Randeraad-van Der Zee, & Chinapaw, 2017). Michie et al., (2009) found some evidence suggesting that interventions with a small set of behavioural change techniques tended to work better for low-SES groups than those with combining a very large number of techniques. They also found that providing information, facilitating goal setting, prompting barrier identification and planning social support were the most common techniques utilized, and that these simple techniques may be especially helpful in low-income groups. Importantly, the authors suggested that these techniques may work best in combination. Providing information on the consequences of health behaviour can motivate people to change, whereas helping people to form specific, achievable goals, identify barriers and enhance their social support may help people to translate motivation into action (Michie et al., 2009). In contrast, providing information on the consequences of behaviour change alone is unlikely to lead to long-term behaviour change.

Furthermore, reviews also indicated that certain intervention approaches may facilitate the promotion of behaviour change in this at-risk population. Importantly, studies have suggested that health inequalities between socioeconomic groups may partially stem from the fact that higher-SES groups are often already in more advanced stages of change (Adams & White, 2007), and are thus more willing to join (Grandes et al., 2008; Lakerveld et al., 2008) and less likely to dropout from health promotion interventions (Callaghan et al., 2005). Therefore, research on behaviour change interventions with low-SES groups have highlighted the importance of involving peers, parents and community-members in the process of development and implementation of the intervention (Everson-Hock et al., 2013), since these strategies can increase the relevance and attractiveness of the intervention to this target group. In support of this premise, a meta-analysis found that weight loss interventions with children and adolescents that involve parents have greater success (Niemeier, Hektner, & Enger, 2012). Another review with interventions with low-SES adolescents found further evidence for that premise from studies involving adolescents and parents in the development and delivery of interventions (Kornet-van Der et al., 2017). For example, one study with adolescent girls (Lindgren, Baigi, & Apitzsch, 2014) involved participants in the process of intervention development. Participants' interests and needs were considered when developing intervention components, which enhances the attractiveness of the intervention and ensures that the intervention components fit the preferences of the target group. In another study, Lubans et al., (2011) trained adolescents boys to become PA leaders and involved them in the delivery of the intervention. The authors suggested that this enhanced the students' sense of responsibility and their commitment to understand the intervention material. Moreover, they also suggested that such peer-led delivery of intervention components can enhance the motivation of other students to participate. Such approaches can increase the attendance and retention of participants, hence increasing intervention effectiveness.

Additionally, it is also important to consider the kind of activities and intervention components are most appropriate for this target group. A research with low-SES female adolescents found that they particularly enjoyed experiential activities, such as cooking lessons, hiking or swimming outdoors, compared to didactic lessons (Yaroch, Davis, & Wang, 2019). Such experiential activities can improve participant's skills (e.g. cooking), self-efficacy (i.e. through mastery experiences) and outcome expectations. Thus, offering these types of activities to low-SES adolescents, and possibly also to their parents, seems to be a promising intervention strategy for improving health behaviours in this population. In support of this notion, a recent study with low-SES adolescents found that an intervention involving outdoor activities such as kayaking, rock wall climbing and swimming was effective in promoting weight loss (Carraway et al., 2014). Increases in PA may have been a result of increased enjoyment and thus greater participation in these types of activities. Most of these activities are quite affordable to offer, and may thus be particularly promising strategy for adolescents from low-income communities, in which the costs of sport activities can be a considerable barrier for adolescent PA (Beaulac et al., 2010; Kamphuis, Lenthe, Giskes, Brug, & Mackenbach, 2007; Romero, 2005).

Evidence from sleep interventions

Overview

Based on the determinants of sleep, several intervention strategies have been applied to improve youth sleep quality and duration. One interesting intervention focused on changing environmental factors, and aimed to improve youth sleep duration by delaying high school starting times by 1 hour and 25 minutes (from 7:15 am to 8:40 am) (Wahlstrom, 2002). The shift resulted in an increase of 1 hour in sleep duration, as well as improvements in attendance rates and reduction of symptoms of mental health problems. Besides environmental factors, Interventions to improve sleep generally include at least one module on sleep hygiene. Typically, this module covers three main sleep hygiene categories of sleep routine, sleep environment and eating and drinking habits before bedtime, as these have been shown to be related to sleep quality and duration.

Moreover, similarly to PA and eating interventions, multicomponent sleep interventions addressing multiple risk factors of sleep disturbance are promising. For example, one intervention effectively combined sleep hygiene, cognitive therapy and stress reduction techniques to improve sleep and thereby reduce substance use in adolescents (Tan et al., 2012). Another multicomponent sleep intervention combined sleep hygiene with mindfulness techniques to reduce stress and anxiety to improve the sleep of adolescent girls (Bootzin & Stevens, 2005). They observed significant improvements in sleep following the interventions. Importantly, these interventions generally relied on school involvement for their implementation, and they targeted intervention efforts by screening participants for sleep problems. These interventions exemplify that various effective strategies are available for influencing youth sleep. Multicomponent targeting important risk factors of sleep problems are particularly promising to improve youth sleep, and consequently positively impact

youth mental and physical health. Remarkably, several studies have also found that internet-based cognitive behavioural therapy is effective in reducing sleep problems in youth and in adults (Zachariae, Lyby, Ritterband, & Toole, 2016), thus the use of digital applications should also be considered.

Conclusion

In conclusion, effective interventions to improve the mental health and reduce or prevent overweight and obesity in children and adolescents should focus on promoting PA and healthy dietary behaviours in this population. Particularly with regards to improving mental health, interventions to improve the sleep of adolescents are also promising strategies. Additionally, it seems promising to address certain specific behaviours, such as consumption of sweetened beverages, fruit and vegetable consumption and screen time. Furthermore, to promote behavioural change, it is crucial to target multiple psychological, social and environmental determinants of PA and dietary behaviours.

With regards to psychological determinants, it is important to address motivational constructs first, such as outcome expectancy and self-efficacy. In order to form the intention to change one's behaviour, individuals must expect positive consequences from performing the behaviour, and they must have confidence in their ability to change. Subsequently, it is also important for interventions to incorporate strategies to improve the self-regulation of children and adolescents, helping them to translate their intentions into action. For instance, planning strategies have been shown to be effective. Other strategies, such as self-monitoring and tailored prompts and feedback, have also been shown to result in more effective interventions. Importantly, motivational strategies are appropriate for individuals that are not yet ready or motivated to change, but are rather ineffective for individuals who are motivated to change, but lack the tools and capacity to initiate and maintain the desired behaviour change. Conversely, strategies that help individuals self-regulate their behaviour are particularly effective for individuals who are already motivated, but are rather ineffective for individuals who are not motivated to change. Thus, the application of intervention components must be tailored to the psychosocial determinants of the individual, particularly to his or hers levels of motivation and readiness-to-change (See transtheoretical or stage of change model by Prochaska; Krebs et al., 2018; Sarkin et al., 2001).

Internet-based applications are promising platforms for the delivery of such tailored interventions, seeing as interventions components can be automatically tailored to the individuals' needs. Additionally, digital interventions are cost-effective, scalable and can combine the use of several interactive components to enhance user experience and support skill development. Moreover, with regards to intervention setting, interventions to reduce or prevent overweight and obesity in children and adolescents should consider involving the parents and the community. Educating and guiding parents towards healthier choices seems important in changing the health behaviour of children and adolescents. Finally, school involvement may be beneficial, since it facilitates contact with and recruitment of the target population (i.e. children and adolescents) and changes at the environmental and policy level can be implemented. It is interesting whether internet-based interventions targeting psychosocial determinants of behaviour could be combined with nudges in the school environment to more effectively reduce or prevent childhood and adolescence obesity.

Example of successful intervention strategies:

For changing PA and eating behaviours

- Utilizing reminders through social media and internet/mobile-based applications is a promising strategy to increase fruit and vegetable consumption. **See example:** *Intervention to improve fruit and vegetable consumption:* Conner, T. S., Brookie, K. L., Carr, A. C., Mainvil, L. A., Margreet, C., & Vissers, M. (2017). Let them eat fruit ! The effect of fruit and vegetable consumption on psychological well-being in young adults : A randomized controlled trial, 1–19. https://doi.org/10.1371/journal.pone.0171206

- Providing children with incentives (i.e. 30 euros gift cards) to achieve their pedometer step count for most days of the month. Example of incentive-based PA intervention with children. **See example:** Finkelstein, E. A., Tan, Y., Malhotra, R., Lee, C., Goh, S., & Saw, S. (2013). A Cluster Randomized Controlled Trial of an Incentive-Based Outdoor Physical Activity Program. The Journal of Pediatrics, 163(1), 167-172.e1. https://doi.org/10.1016/j.jpeds.2013.01.009

- Addressing sociocognitive factors. Multicomponent interventions for PA and healthy eating addressing self-efficacy, outcome expectation, skill mastery and self-regulation capabilities can be effective. Promising strategies include increasing children's and parents' self-efficacy through setting realistic and achievable goals, providing necessary skills to achieve mastery, and improving self-regulation in maintaining healthy weight and healthy lifestyles. Family involvement seems important, particularly for younger children. See example: Chen, J., Weiss, S., Heyman, M. B., & Lustig, R. H. (2009). Efficacy of a child-centred and family-based program in promoting healthy weight and healthy behaviors in Chinese American children : a randomized controlled study, *32*(2), 219–229. https://doi.org/10.1093/pubmed/fdp105

- Multicomponent digital interventions to improve physical activity and eating behaviours in youth. Digital platforms offer inexpensive means of delivering health interventions, and often target both motivational and self-regulatory components. By incorporating multiple motivational strategies, and elements of gamification, digital interventions can promote greater engagement with intervention material. Additionally, digital interventions facilitate the tailoring of intervention techniques to the needs of the participants. Reviews of digital interventions with youth have shown that such interventions are effective in changing physical activity and diet behaviour (Rose et al., 2017). **See examples:**
    - Patel, M. S., Benjamin, E. J., Volpp, K. G., Fox, C. S., Small, D. S., Massaro, J. M., … Murabito, J. M. (2019). Effect of a Game-Based Intervention Designed to Enhance Social Incentives to Increase Physical Activity Among Families The BE FIT Randomized Clinical Trial, *19104*. https://doi.org/10.1001/jamainternmed.2017.3458
    - Smith, A. J. J., & Morgan, P. J. (2019). Smart-Phone Obesity Prevention Trial for Adolescent Boys in Low-Income Communities: The ATLAS RCT, *134*(3). https://doi.org/10.1542/peds.2014-1012
    - In Nederland is door Isprout in samenwerking met Sportbedrijf Arnhem en Ristretto (Utrecht) een app ontwikkeld voor groepen 7 en 8 van de basisschool en bevat een lesmethode. Met de app bekijk je vlogs en challenges en upload je foto's. iSprout is een spel dat in groepsverband wordt gespeeld

- Choice architecture, or nudges, have also been attracting increased attention as promising and relatively inexpensive health promotion strategies. For example, introducing health labels highlighting healthy food options in a secondary school canteen was shown to increase the selection of healthy food items during the intervention period (Ensaff et al., 2015). **See example:** Ensaff, H., Homer, M., Sahota, P., Braybrook, D., Coan, S., & Mcleod, H. (2015). Food Choice Architecture: An Intervention in a Secondary School and its Impact on Students' Plant-based Food Choices, 2(2), 4426–4437. https://doi.org/10.3390/nu7064426

To improve youth sleep duration and quality

- Policy-level interventions that change the starting time of schools have also shown to be effective in improving youth sleep duration. Simply delaying school starting times can have a tremendous impact on how much sleep adolescents are getting. See example: Wahlstrom, K. (2002). Changing Times: Findings From the First Longitudinal Study of Later High School Start Times.

- Addressing motivation for sleep, sleep hygiene, mindfulness and stress/anxiety reduction techniques are all promising strategies. See example: *Multicomponent intervention to improve sleep in adolescent girls:* Bei, B., Byrne, M. L., Ivens, C., Waloszek, J., Woods, M. J., Dudgeon, P., … Allen, N. B. (2013). Early Intervention in the Real World Pilot study of a mindfulness-based , multi-component , in-school group sleep intervention in adolescent girls, (June 2010), 213–220. https://doi.org/10.1111/j.1751-7893.2012.00382.x

- Several versions of internet-based cognitive behavioural therapy for insomnia have been developed and tested. These often addresses most of the psychosocial and environmental determinants of sleep quality and duration, and many of these interventions have been found to be effective. Systematic reviews have shown that internet-based cognitive behavioural therapies for insomnia significantly improve subject's sleep quality and duration(Luik, Kyle, & Espie, 2017; Zachariae et al., 2016). See example: Ritterband, L. M., Thorndike, F. P., Ingersoll, K. S., Lord, H. R., Gonder-frederick, L., Frederick, C., … Morin, C. M. (2019). Effect of a Web-Based Cognitive Behavior Therapy for Insomnia Intervention With 1-Year Follow-up A Randomized Clinical Trial, *22908*. https://doi.org/10.1001/jamapsychiatry.2016.3249

- Jongeren Op Gezond Gewicht (JOGG) is een landelijke stichting die samen met gemeenten en partners streeft naar een gezonde omgeving voor kinderen en jongeren. Door middel van verschillende leefstijlthema's zet JOGG in op een gezondere omgeving. Youngworks ontwikkelde in overleg met de Hersenstichting een aanpak voor kinderen op basisscholen onder het thema 'Slaap lekker'. Kinderen leren op hun niveau welke goede dingen slaap doet voor je lijf. Zo gaan ze een week hun eigen slapen 'monitoren'. Dit doen ze onder andere met een slaapdagboekje met vragen.

Take home messages:

- We advise LekkerFit to target multiple psychosocial and environmental factors, particularly when attempting to influence complex behaviours such as PA, SB and eating habits.

- We advise LekkerFit interventions to target motivational determinants first, such as outcome expectancy and self-efficacy. That is particularly true for individuals who are unmotivated to change. Several strategies can be used to achieve this, such as providing information, modelling, reinforcing effort towards behaviour and emphasizing mastery experiences. However, that is not sufficient. Motivating adolescents to change their PA, SB or eating habits is only the first step. It is important to also help them translate their intentions/goals into action. See below.

- We advise LekkerFit to include components in their interventions to improve the self-regulation of children and adolescents. This is particularly true for individuals who are already motivated to change. Some examples of effective strategies are: Action planning (i.e. specifying when, where and how the behaviour will be performed), tailored feedback and prompts.

- Interventions should be tailored to the characteristics of the participants, which can be done in several ways. For instance, one possibility is to focus intervention efforts on those with the highest risk of future health problems. This can be done by screening participants, or by targeting participants from high-risk populations, such as individuals from low-SES. Another approach is to tailor the intervention components based on the psychosocial determinants of the behaviour, for instance, on whether the individual is motivated to change or not. This can be determined by assessing motivational factors, or by assessing an individuals' readiness-to-change (stage of change questionnaires).

- We advise LekkerFit to consider utilizing internet-based interventions to target determinants of health behaviours.

- We advise LekkerFit to consider involving parents in their interventions. Utilizing direct methods to involve parents seems to be the most promising approach.

- We advise LekkerFit to consider including choice architecture nudges to their interventions.

- We advise LekkerFit to prepare a comprehensive and detailed evaluation procedure to assess the characteristics of the population, the environmental and psychosocial determinants of health behaviours, as well as the impacts of the intervention on these determinants and on health behaviours.

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