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Correlates of longitudinal changes in the waist-to-height ratio of primary school children: Implications for prevention

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ABSTRACT

Objective. To investigate correlates of changes in waist-to-height ratio (WHtR) in primary school children in order to identify modifiable factors usable for prevention.

Methods. Outcome evaluation of a statewide health promotion program in Baden-Württemberg, Germany. Baseline (2010) and follow-up (2011) measurements provided data for the calculation of changes in WHtR. Further information on the health and living conditions of the children were assessed in parental questionnaires. Anthropometric measures were taken in 1733 (50.8% male) first and second grade children (age at baseline 7.1 ± 0.6 years) by staff trained according to ISAK-standards. Stepwise linear regression analysis was applied to identify variables with influence on changes in WHtR.

Results. According to the resulting regression model, changes in WHtR towards an increase were influenced by at least one parent being overweight/obese, at least one parent who smoked, low household income, higher age of the child and the skipping of breakfast. There was no clustering effect in schools observed.

Conclusion. A promising target for prevention of gain in WHtR in primary school children is to ensure the regularity of breakfast. Smoking cessation as well as dietary improvements would not only help children's health but also the health of their parents. The socioeconomic influence on the development of an unhealthy weight status has already been acknowledged and should be extensively targeted by all of society and policy makers.

Introduction

Abdominal obesity is an underestimated, if not ignored, health risk with a high contribution to several non-communicable diseases (NCD) (Smith & Haslam, 2007; Balkau et al., 2007; Scholze et al., 2007). To define abdominal obesity, a threshold of waist-to-height ratio (WHtR) of 0.5 as recommended by Ashwell and Hsieh (Ashwell & Hsieh, 2005), and confirmed in the systematic review by Browning et al. (Browning et al., 2010) can be used and is also applicable for children. Some researchers have detected rising numbers of abdominal obesity in children (Griffiths et al., 2013; Garnett et al., 2011; Li et al., 2006), while others have reported a leveling off in terms of overweight and obesity defined by body mass index (BMI) (Olds et al., 2011; Rokholm et al., 2010; Wabitsch et al., 2014). The latter may, inter alia, be due to the fact that BMI fails to identify over a quarter of children with excess body fat percentage (Javed et al., 2014). Abdominal obesity is very likely to continue from childhood to adolescence (Chrzanowska et al., 2012). Children with abdominal obesity experience lower health-related quality of life (HRQoL), are more often sick, and have more visits to a physician than their lean peers (Kesztyüs et al., 2013; Kesztyüs et al., 2014). Each missed day at school implies a hazard to academic achievement and each additional visit to a physician is related to higher health care costs (Kesztyüs et al., 2013).

Obesity and NCDs pose an enormous economic burden on states and national economies. Macroeconomic simulations suggest a cumulative output loss of 75% of global GDP in 2010 for NCDs (Bloom et al., 2011). The direct costs of obesity are estimated to €22.4 billion in Germany in 2020, plus indirect costs of €3.3 billion through losses in productivity (Knoll & Hauner, 2008). In the United States, obesity-attributable medical costs for non-institutionalized adults were estimated at $190.2 billion or 20.6% of national health expenditures in 2005 (Cawley, 2013). Additionally, childhood obesity was responsible for $14.1 billion in direct medical costs annually (2002–2005) (Trasande & Chatterjee, 2009). An early implementation of evidence-based health promotion in childhood could help to reverse the trend, but successful and cost-effective programs are rare (Waters et al., 2011; Langford et al., 2014). For abdominal obesity in children, it is crucial to find associated factors that are modifiable and can be targeted by preventive measures.

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There is a vast amount of literature concerning correlates of weight gain based on BMI, but little is known on the factors leading to abdominal obesity in school children. The importance of this measure especially in children in comparison to BMI is described above. To our knowledge, this is the first study investigating correlates of longitudinal changes in WHtR in primary school children, representing changes in abdominal obesity. The aim is to identify modifiable correlates of changes in WHtR in primary schoolchildren and to consider their usability for primary prevention and health promotion.

Materials and methods

Study design

This research is based on the outcome evaluation of a health promotion program for primary schools in the state of Baden-Württemberg, Germany. The underlying program "Join the healthy boat" provides scientifically developed materials for teachers, pupils and their parents aiming at the development of healthy choices and a healthy lifestyle. To assess the effects, a cluster-randomized controlled trial ("Baden-Württemberg Study") was set up, with baseline measurements in 2010 and a follow-up after one year in 2011. The ethics committee of Ulm University approved the study protocol and the study is registered on the German Clinical Trials Register (DRKS) under the DRKS-ID: DRKS00000494. Details on the study have already been published elsewhere (Dreyhaupt et al., 2012).

Participants and data

Parents were asked for their written informed consent. Data from direct measurements of children's height, weight and waist circumference (WC) at both baseline and follow-up, were available for 1733 participants, data from parental questionnaires for 1545 (89%) participants. Parents provided information on their own lifestyles, health behavior, and anthropometric data and the lifestyle, health behavior, physical activity patterns and the living environment of their children.

Demographics

The parental level of education was assessed and assigned to the respective level according to the CASMIN classification (Brauns & Steinmann, 1999). Family education level was determined as the highest level of two parents or the level of a single parent who cared for the child. Family education was dichotomized for analysis; elementary and intermediate education levels were taken together in one group, tertiary level in another. The child's migration background was defined as at least one parent being born abroad or at least one parent mainly having spoken a foreign language during the child's first years of life. Household income was graded according to the German KiGGS survey (Lange et al., 2007) and dichotomized for analysis into two groups, the lower group including monthly household incomes of < €1750.

Health and lifestyle characteristics

Parents gave information about maternal smoking during pregnancy, and breastfeeding. Items concerning children's behavior were taken from the validated questionnaires of the German KiGGS survey (Kurth, 2007). They were answered using a 5-point Likert scale: frequency of consuming softdrinks, frequency of playing outside (nearly every day, 3–5 times a week,1–2 times a week, less than 1 time a week, never), and time spent with screen media (never, about 30 min/day, about 1–2 h/day, about 3–4 h/day, more than 4 h/day). Variables were dichotomized for analyses (soft drinks > 1 time per week, playing outside > 60 min/day, screen media > 1 h/day). Parents stated the frequency of breakfast before school for their children on a 4-point scale, the results were subsequently dichotomized for analyses (never, rarely vs. often, always). Furthermore, they were asked on how many days a week their children were physically active on a moderate to vigorous level for at least 60 min a day, as recommended by the WHO (World Health Organisation (WHO), 2010). This variable was dichotomized for analyses at the median (physically active ≥ 4 days/week ≥ 60 min/day). Additionally, parents gave information about their own health behavior such as smoking, and were asked to rate their health awareness on a 4-point scale, the results were then dichotomized for analyses (not at all, little vs. strong, very strong).

Anthropometric measurements

Anthropometric measurements of the children were taken by trained staff according to ISAK-standards (Marfell-Jones et al., 2006). The children's height was measured to the nearest 0.1 cm (Stadiometer, Seca®, Germany), and body weight to the nearest 0.1 kg using calibrated and balanced portable digital scales (Seca®, Germany). WC was measured midway between ileac crest and lower costal arch to the nearest 0.1 cm using a flexible metal tape (Lufkin Industries Inc., Texas, USA). The children's BMI was calculated as weight divided by height squared (kg/m^2). Excess weight and obesity were defined at or above the 90th and 97th age- and gender-specific BMI percentiles according to German reference data (Kromeyer-Hauschild et al., 2001). WHtR was calculated as the ratio of WC and height in centimeters, and subsequently participants with a WHtR ≥ 0.5 were categorized as abdominally obese (McCarthy & Ashwell, 2006).

Parental BMI was calculated from self-reported weight and height data in the questionnaires, and categorized as overweight (BMI > 25.0) and obese (BMI > 30.0), according to the international classification of the World Health Organization (WHO) (World Health Organisation (WHO), 1995). Parental WHtR was calculated as the ratio of self-reported WC to height and abdominal obesity defined at and above a WHtR threshold of 0.5 (Vandenbroucke et al., 2007).

Missing data

Common to observational studies is the problem of missing data, which may lead to bias (Ahrens et al., 2014). Baseline differences between records with and without missing variables for the final regression model were examined as described in the statistical analysis section.

Statistical analyses

Differences in baseline characteristics between boys and girls as well as between participants with and without missing values for the final regression model were tested for their statistical significance. The Mann–Whitney-*U* test or t-test for continuous data and Fisher's exact test for categorical data were applied as appropriate to scale level and distribution of the data. The significance level was set at $\alpha < 0.05$ for two-sided tests. All analyses were carried out using the statistical software packages IBM SPSS Release 21.0 for Windows (SPSSInc, Chicago, IL, USA).

The changes in height, WC and WHtR were calculated as the differences between the values at baseline and the respective values at follow-up. Because of their small size after the decimal point, the resulting numbers of WHtR were then multiplied by 10^2 in order to receive understandable and interpretable values in the regression model. Thus, one unit in dependent variable of the regression model represents 0.01 WHtR. Based on the relevance of content and association with the outcome, all variables listed in Table 1 were included in the stepwise, linear regression analysis as potential explanatory variables. To account for the clustering of data in schools, a possible school-effect was examined in a linear mixed model using the statistical software R Release 3.1.2 for Windows (http://cran.r-project.org/).