A Biopsychosocial Process Model of Health and Complaints in Children and Adolescents

LENA LÄMMLE
Technische Universität München, Germany
ANNETTE WORTH
Pädagogische Hochschule Schwäbisch Gmünd, Germany
KLAUS BÖS
Universität Karlsruhe (TH), Germany

ACKNOWLEDGEMENTS. This research was supported by the Luxembourgian Ministère de l'Éducation nationale et de la Formation professionnelle, the Département ministerial des Sports, the Service de Coordiantion de la Recherche et de l'Innovation pédagogiques et technologiques (SCRIPT) in and the Ministère de la Santé in the years 2004 to 2007.

COMPETING INTERESTS: None declared.

ADDRESS. Correspondence should be directed to:
LENA LÄMMLE, Department of Sports Psychology, Technische Universität München, Conollystrasse 32, D-80809, Munich, Germany.
[Tel. +49 (89) 289 24669; Fax +49 (89) 289 24555;
email: lena.laemmle@tum.de]

Journal of Health Psychology

Los Angeles, London, New Delhi,
Singapore and Washington DC
www.sagepublications.com
Vol 16(2) 226–235
DOI: 10.1177/1359105310377812

Abstract

The purpose of the study was to test a biopsychosocial process model based on theoretically and empirically supported factors previously found to influence health and complaints in children and adolescents. Participants (N = 823) of the ages of nine, 14 or 18 were administered parts of the Health Behaviour in School-Aged Children Questionnaire and a physical activity questionnaire. They subsequently underwent physical fitness tests and a medical examination. For complaints, direct and indirect influences over four levels (socioeconomic status, physical activity of relatives and peers, physical activity and physical fitness) were shown, but the findings did not hold for health. The interpretation of expected and unexpected results is discussed.

Keywords

- *complaints*
- *health*
- *health behaviour*
- *holistic process model*

BEHAVIOURAL patterns established in childhood have been found to carry over into adulthood, and some of these have been associated with adult morbidity and mortality. Primary examples are eating patterns (EPs; St-Onge, Keller, & Heymsfield, 2003) and physical activity (PA; Riddoch, Savage, Murphy, Cran, & Boreham, 1991). The decline in the quality of diets over the past 20 years (St-Onge et al., 2003) and the decreasing levels of PA (Boreham & Riddoch, 2001) have been shown to be closely related to an increase in childhood and adolescent obesity (Krebs et al., 2003). Childhood obesity as well as adult obesity has been associated with metabolic dysfunctions and hypertension (Spiotta & Luma, 2008; St-Onge et al., 2003). Changing EPs and PA behaviour are active processes where considerable conscious effort is required to change well-established habits (Taylor & Horner, 2008). Thus, to overcome the epidemic of overweight and obesity in children and adolescents, the focus must lie on prevention rather than treatment (Dehghan, Akhtar-Danesh, & Merchant, 2005). Nevertheless, research has also shown that well-designed, well-implemented school programmes can effectively improve children's and adolescents' PA and EPs. Because such prevention or health promotion interventions should also be cost-effective, risk factors of unhealthy stable behaviours and their consequences should be well established (Wang et al., 2008). The aim of this article was therefore to examine several initial conditions of health and complaints of children and adolescents within a biopsychosocial process model (model), which is described in the following section.

A model of health and complaints

In accordance with other research groups, the model is a multi-level approach (e.g. Nigg, Borrello, Maddock, & Dishman, 2008) consisting of five levels with (nearly) unchangeable conditions (e.g. socioeconomic status; SES) on the first level, changeable conditions (e.g. motivation) on the second level, health behaviour (e.g. PA, EPs) on the third level, body composition (e.g. measures of health, physical fitness; PF) on the fourth level and complaints (e.g. psychosomatic) on the fifth level. Furthermore, it is assumed that (nearly) unchangeable conditions can influence changeable conditions and that both can result in behaviours affecting body composition, which leads to complaints. Interferences within each level are possible. In the present study, the model was specified with SES on the first level, PA of the environment (PAE) and intrinsic motivation of children and adolescents being physically active (motivation) on the second level, PA itself and EPs on the third level, PF and health on the fourth level and psychosomatic complaints (complaints) on the last level (see Fig. 1).

In the following section, the holistic biopsychosocial approach involving health and complaints is theoretically substantiated. Subsequently, this is followed by the theoretical and empirical support for the assumptions within the model.

Theoretical background of the model

Bandura's social cognitive theory (SCT) describes factors that affect and determine behaviour. More precisely, it specifies mechanisms through which determinants work and human health is seen not only as an individual factor, but also as a social matter. A multifaceted causal structure is assumed (Bandura, 2004). In the present study, we focused on the central constructs of outcome expectancies, facilitators and impediments in the regulation of motivation, PA and EPs, also referring to the ecological systems theory (EST). Here, human development is seen from an interactive contextual perspective (Bronfenbrenner & Morris, 1988). A person's development or change has to be considered in not only the immediate context, but also with regard to the contexts in which that context is embedded. The development of childhood and adolescent health factors is assumed to be shaped by family and peer characteristics and the larger social contexts as a result of the influence on the family and on peers. Furthermore, such consideration of psychosocial factors is closely related to the risk factor model of Schäfer and Blohmke (Schäfer, 1978). A complex network of influential social, psychological and physical factors is assumed and designated as 'at-risk' factors. In contrast to the risk factor model, the aim of the model is to identify factors that can improve health and decrease the complaints of children and adolescents, similar to the salutary factors such as physical fitness, social support and the way of life as described in the salutogenesis model of Antonovsky (1979).

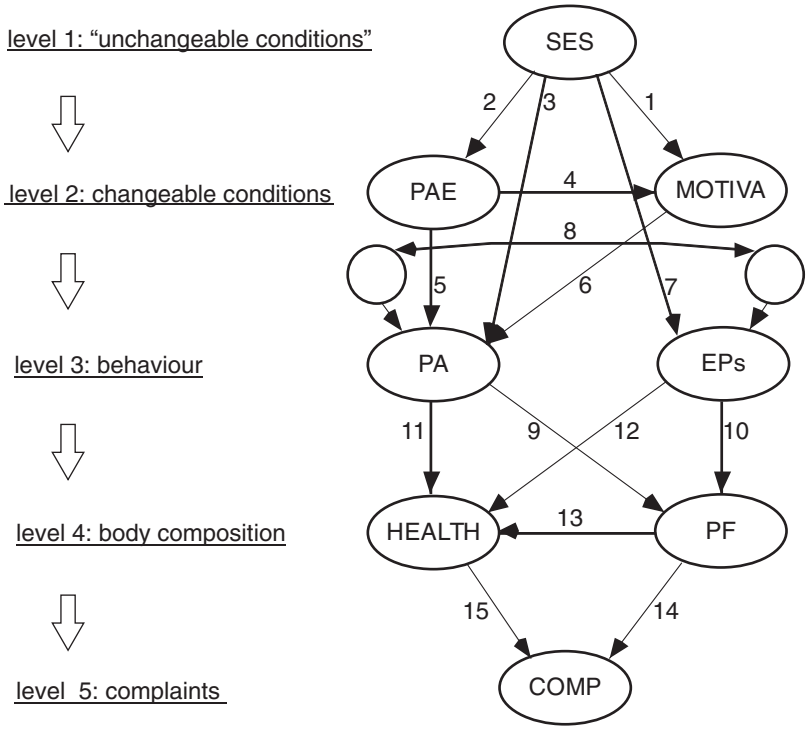

Figure 1. A biopsychosocial process model. SES = socioeconomic status; PAE = physical activity of relatives and peers; MOTIVA = intrinsic motivation to be physically active; PA = physical activity; EPs = eating patterns; PF = physical fitness; COMP = psychosomatic complaints.

Empirical and theoretical support for the assumptions within the model

SES and (1) motivation, (2) PAE, (3) PA

Comprehending the socioeconomic correlates of health behaviour patterns can contribute to research on healthy behaviours (Rimal, 2002). Understanding children's and adolescents' motivation to be physically active has been a subject of interest for many researchers, and studies revealed environmental influences (Yan & McCullagh, 2004). Research on the relationship of SES and motivation is rare and indicates that children and adolescents are more highly motivated to be physically active when their SES is lower (Public Authorities for Social Affairs, the Family and Consumer Protection, 2006; Schmidt, Hartmann-Tews, & Brettschneider, 2003). Health behaviour, such as PA, appears to be influenced further by SES itself (Winster, 1996). For adults, it has been shown that, due to such factors as a reduced access to fitness facilities because of their lower SES, individuals are less likely to participate sufficiently in PA (Kamphuis, van Lenthe, Giskes, Brug, & Mackenbach, 2007). However, there has been some evidence (Voss, Hosking, Metcalf, Jeffery, & Wilkin, 2008; Ziviani et al., 2008) that although children from lower-income families have reduced access to sports facilities, this does not lead them to be less active. As an explanation, Ziviani and colleagues (2008) pointed out that children with lower SES more frequently make use of the forms of unstructured play that is typical of young children. As the children get older, however, it is more beneficial for them to become involved in structured activities (Fletscher, Nickerson, & Wright, 2003), which often require access to facilities, and these are not equally available for all (Estabrooks, Lee, & Gyurcsik, 2003). Recent research has shown that adolescents from higher SES families have reported higher levels of PA than those from lower SES families (Hanson & Chen, 2007). By contrast, research performed before 1999 has shown no relationships

between PA and SES for children or adolescents (Sallis, Prochaska, & Taylor, 2000). Therefore, the assumptions within the model are that the motivation is higher when SES is lower, the environment is more physically active when SES is higher and there also exists a direct effect on the PA patterns of children and adolescents themselves.

PAE and (4) motivation, (5) PA, (6) motivation and PA

The assumed impact of an active or inactive environment on one's own motivation to be physically active can be ascribed to Atkinson's (1964) expectancy-value theory (EVT). Furthermore, the family has been found to be an important socializing agent in PA and in other behaviours (Wold & Hendry, 1998). SCT provides a theoretical basis for examining parent–child interactions as related to PA patterns (Bandura, 1986). A review of studies between 1985 and 2003 showed mixed findings regarding whether parent PA is a correlate of child PA. Most of the studies indicated no or only weak to moderate correlations. The impact of the parental exercise role was found to decrease as age increased (Gustafson & Rhodes, 2006). More recent research has found some evidence that children are more likely to be PA with siblings and parents than with peers (Woods, Bolton, Graber, & Crull, 2007), although PA patterns of peers have also been found to influence children's and adolescents' PA levels (Anderssen & Wold, 1992), mainly with increasing age (Deflandre, Lorant, Gavarry, & Falgairette, 2001). Finally, motivation, expressed by factors such as enjoyment, interest or competence, has been shown to be predictive of PA behaviour (Woods et al., 2007). Therefore, the assumptions within the model are that for a more active environment, the motivation in children and adolescents is higher, a higher motivation comes along with more PA and there is also a direct PA enhancing effect of an active environment.

(7) SES, (8) PA and EPs

Family income plays an important role in EPs because of its links with the quality and quantity of food available. Children and adolescents from lower income families have demonstrated poorer nutritional intake than those from families with higher incomes (O'Dea & Wilson, 2006). There is some evidence that PA can act as a facilitator for other health behaviours like healthy eating (Wing et al., 2001). In a review, Sallis et al. (2000) found healthy diet to be one of the most consistent correlates of PA in children, but this relationship did not hold for adolescents. Therefore, the assumptions within the model are that EPs are better when, at the same time, SES is higher and there is a relation between PA and EPs.

(9) PA, (10) EPs and PF

Studies have suggested that regular engagement in PA is related to the attainment of standards addressing PF (Castelli & Valley, 2007). Currently, little is known about the relationship between EPs and PF. In a recent study, frequent snacking and a frequent habit of skipping breakfast were shown to be associated with lower PF (Chen et al., 2005). Therefore, the assumptions within the model are that PF is better when PA levels are higher and when EPs are better.

(11) PA, (12) EPs, (13) PF and health

There is an increasing awareness of the importance of regular PA for children and adolescents as a determinant of public health (World Health Organization, 2004). Regular PA can be helpful in delaying the development of obesity (Gutin, Yin, Humphries, & Barbeau, 2005). Furthermore, the strongest risk factor for elevated blood pressure in childhood and adolescence seems to be obesity. Obesity is also a consequence of unhealthy EPs (Rimal, 2002). Besides PA and EPs, PF is also associated with a lower risk of overweight and obesity in children (Brunet, Chaput, & Tremblay, 2007) and adolescents (Burke et al., 2006). Therefore, the assumptions within the model are that better health is associated with more PA, better EPs and better PF.

(14) PF, (15) health and complaints

PF has been shown to be related to general health and well-being in children (Eiberg et al., 2005). Obesity, as an important health parameter, has been shown to be associated with physical and psychological health complaints (Janssen, Katzmarzyk, Boyce, & Pickett, 2004). Nevertheless, subjective health complaints such as headaches, backaches and so forth, are common in children and adolescents (Currie et al., 2006), and only in a few instances have such symptoms been related to a defined diagnosis or disease (Garralda, 1992). However, further research questions are concerned with whether or not complaints are reduced when PF and health are better.

Most of the above mentioned findings are based on bivariate correlations. Finally, the concept of a process model is interesting from a third perspective, namely, to examine whether the correlations still hold when regarding them more holistically.

Method

Sample and study

Analyses were based on the Luxemburg physical activity, motor performance and health survey for children and adolescents, which was conducted in 2004. The survey is a nationwide, cross-sectional study on the health status of children and adolescents of the ages of nine ($M = 9.37$; SD = 0.41), 14 ($M = 14.13$; SD = 0.35) and 18 ($M = 18.13$; SD = 0.31), conducted by the Luxembourgian Ministère de l'Éducation nationale et de la Formation professionnelle, Service de Coordiantion de la Recherche et de l'Innovation pédagogiques et technologiques (SCRIPT) in co-operation with the Ministère de la Santé and the University of Karlsruhe. These three age groups were chosen since economic conditions did not allow for the examination of all ages from 9–18 years. Furthermore, the educational system in Luxembourg is divided into the three levels of primary school, secondary school level 1 and secondary school level 2. The experts at SCRIPT chose one relevant age group for each school level. The data set was collected in its entirety from 823 children and adolescents (373 girls and 450 boys). Participation was voluntary and the study was conducted according to the ethical requirements of SCRIPT. Participants were randomly chosen nationwide through SCRIPT.

Measurements

SES, EPs and complaints These data were collected with the use of the Health Behaviour in School-Aged Children (HBSC) Questionnaire. Participants were asked their parents' occupations, and scales were made using the International Standard Classification of Occupations (ISCO-88). For validation, this scale was compared to the results of the Federal Statistical Office in 2004 for households with at least one child and was found to demonstrate high consistency. As a third SES measure, the socioeconomic milieus of the schools were used, as assigned by experts at SCRIPT. As an eating pattern, nine items from the HBSC scale that could be clearly assigned to healthy or unhealthy eating, such as fruit and vegetable consumption or sugar-sweetened beverage consumption, were used. Complaints such as headaches, stomach aches, sleeping disturbances and so forth, were selected by medical experts of the Ministère de la Santé with regard to the most common of the HBSC items.

Motivation According to the Theory of Reasoned Action, attitude, and as a follow-up, intention towards PA, are important predictors of PA levels. Attitude is a function of the belief that participation in PA will result in certain outcomes (Ajzen & Fishbein, 1980). Such outcome expectations include fun, social aspects and skill development (Biddle, 1998). Therefore, nine statements, for example, 'I participate in sports in order to have something to do with my friends' and 'I participate in sports in order to have fun', were used and evaluated with the aid of a five-point Likert-type scale, ranging from 1 (*I disagree completely*) to 5 (*I agree completely*; Cronbach's alpha = .90).

PA (of the environment) PA was assessed using a questionnaire containing previously validated items involving the duration, intensity and frequency of physical activity in everyday life, leisure time, school and sports clubs (Bös et al., 2009). The test–retest reliability ranged from $r_{tt} = .72$ to $r_{tt} = .93$. Validity had been tested with a multisensory electronic monitor including a biaxial accelerometer measuring PA (SenseWear Pro 2). Results have shown higher correlations ($r_{min} = .56$, $r_{max} = .66$) in comparison with other PA questionnaires (e.g. Treuth, Hou, Young, & Mayland, 2005). This questionnaire also includes information about the PA patterns of parents, siblings and peers.

PF Participants were tested with eight tests of the 'Motorik'-Module (MoMo) test battery (Lämmle, Tittlbach, Oberger, Worth, & Bös, 2010) to assess a complete PF profile involving endurance (through a bicycle ergometer test), strength (through push-ups, standing long jump and force plate for high jumps), co-ordination under precision demands (through standing on one leg and balancing backwards), co-ordination under time pressure (through jumping sideways) and flexibility (through forward bending of the trunk). The content-related validity of all tests was evaluated as being good ($M_{Significance} = 1.9$, $M_{Practicability} = 1.7$) throughout with regard to significance and feasibility as based upon expert ratings. Furthermore good test–retest reliability coefficients ($r_{min} = .74$, $r_{max} = .96$) were shown.

Health parameters Height was measured with an accuracy of within 0.1 cm and weight of within 0.1 kg for all subjects. BMI was calculated as weight (kg) divided by height squared (m^2). For estimating the amount of body fat, while measuring the subdermic layer of fat, skin-fold thickness was assessed on three measurement points: triceps, back and thorax. Finally, systolic and diastolic blood pressure was measured once in a seated position.

These measures were chosen by the experts of the Ministère de la Santé.

Statistical analysis

Confirmatory factor analyses and bivariate correlations were conducted with AMOS 16.0 using a maximum likelihood algorithm. The assumption of multivariate normality could not be confirmed by the Mardia test (multivariate kurtosis = 47.70, c. r. = 19.37, $p < .05$). Therefore, a Bollen-Stine bootstrap procedure (200 samples) was conducted in order to obtain a corrected p-value for the χ^2 test.

In order to specify a balanced model containing three functional indicators for each latent variable, random parcels were built.

In the analyses, all measurements were controlled for gender and age. This was done in order to achieve more reliable estimates in the model.

Results

Model fit

The model (see Fig. 2) revealed an acceptable degree of overall model fit, $\chi^2(237) = 584.474$, Bollen-Stine p-value = .005; RMSEA = .042; 90% confidence interval:.038 –.047; SRMR = .0499; CFI = .92.

Loadings on the manifest parcels

The loadings on the manifest parcels ranged from low to high (SES: $a = .48$ to $a = 64$; PAE: $a = .28$ to $a = .66$; motivation: $a = .71$ to $a = .79$; PA: $a = .27$ to $a = .74$; EPs: $a = .66$ to $a = .71$; health: $a = .49$ to $a = .84$; PF: $a = .57$ to $a = .81$; complaints: $a = .61$ to $a = .81$), but were all significant ($p < .001$).

Paths and bivariate correlations

SES and (1) motivation, (2) PAE, (3) PA SES showed a significant impact on children's and adolescents' motivation (with higher motivation when SES was lower, $a = –.20$, $p < .01$; $r = .00$, $p = .99$) and PAE (with more PA when SES was higher, $a = .48$, $p < .001$; $r = .51$, $p < .001$), but not on PA itself ($a = –.13$, $p = .18$; $r = .17$, $p < .001$, with more PA when the SES was higher).

PAE and (4) motivation, (5) PA, (6) motivation and PA A more active environment was associated with a higher motivation ($a = .43$, $p < .001$; $r = .34$, $p < .001$). It was also shown to lead to higher PA levels in children and adolescents ($a = .75$, $p < .001$; $r = .71$, $p < .001$). The motivation had no significant impact on PA ($a = .12$, $p = .07$; $r = .40$, $p < .001$, indicating that the higher the motivation, the higher the PA levels).

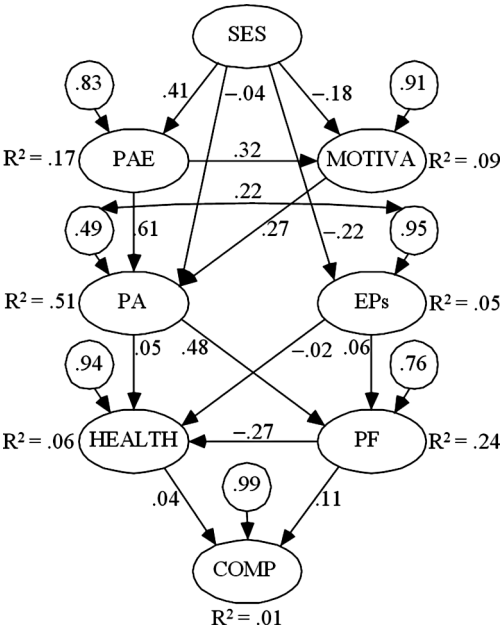

Figure 2. Results of the biopsychosocial process model (standardized solution). SES = socioeconomic status; PAE = physical activity of relatives and peers; MOTIVA = intrinsic motivation to be physically active; PA = physical activity; EPs = eating patterns; PF = physical fitness; COMP = psychosomatic complaints.

(7) SES, (8) PA and EPs The direct path from SES to EPs was significant (with better EPs when SES was higher, $a = –.25$, $p < .001$; $r = –.26$, $p < .001$). The correlation between PA and EPs was not significant ($r = .02$, $p = .75$; $r = –.05$, $p = .28$), with more PA when EPs were better.

(9) PA, (10) EPs and PF PA had a significant impact on PF such that higher activity produced better PF ($a = .61$, $p < .001$; $r = .59$, $p < .001$). EPs did not influence PF ($a = .08$, $p = .06$; $r = .07$, $p = .12$).

(11) PA, (12) EPs, (13) PF and health Neither PA ($a = .04$, $p = .51$; $r = .04$, $p = .46$), EPs ($a = –.08$, $p = .10$; $r = –.09$, $p < .05$, with better health for poorer EPs), nor PF had impacts on health ($a = –.09$, $p = .15$; $r = –.05$, $p = .23$).

(14)PF,(15) health and complaints Complaints were influenced by PF (with fewer complaints when PF was better, $a = .21$, $p < .001$; $r = .22$, $p < .001$)

and health (with fewer complaints when unhealthier, $a = .10$, $p < .05$; $r = .09$, $p < .05$).

Explained variance

Twenty-three per cent of the variance of PAE was explained by SES. The explained variance of motivation was 14 per cent, and 6 per cent of the explained variance in EPs was accounted for by SES. Fifty-seven per cent of PA was explained by PAE, SES and motivation. PA and EPs explained 38 per cent of the variance in PF, and all three explained 1 per cent of the variance in health. Five per cent of explained variance in complaints was due to PF and health.

Discussion

There has been a consensus that unhealthy behaviours are the major causes of chronic diseases. Thus, promoting health behaviour is believed to be necessary for promoting health (US Department of Health and Human Services, 2000). Bivariate correlations have suggested that various biopsychosocial factors are important for health in children and adolescents (e.g. Rimal, 2002). To pay respect to the complexity of promoting and preserving health, the aim of the article was to examine a holistic process model consisting of several causes of good health and of complaints. It was of additional interest to see what happened to previous bivariate findings when using analyses that took more information into account.

SES and (1) motivation, (2) PAE, (3) PA

In accordance with earlier findings (Kamphuis et al., 2007), the present data revealed a more active environment for individuals with a higher SES under a bivariate analysis as well as within the model.

Research findings have indicated that the motivation is higher for those children and adolescents with a lower SES (Schmidt et al., 2003), which is also true for model analysis. Inconsistently, the bivariate finding for SES and motivation revealed a null correlation. These findings can be ascribed to a suppression effect. However, we did not expect these findings; thus, further research is needed to replicate them. Although the present sample size should be sufficient to ensure against spurious effects, the following interpretation should be regarded cautiously. A suppression effect in this case indicated that the reasons for more or less activity of the environment due to SES were not relevant for children's and adolescents' motivation.

For the bivariate latent correlation SES has been shown to be associated with PA directly, but not within the model. A mediation effect was considered as a possible explanation of these findings. Children and adolescents from a higher SES were more physically active only due to higher activity levels of the environment, supporting Bandura's (1986) SCT. Again, these findings were unexpected and future research is needed to replicate these findings. If these findings appear again, considerable implications for intervention programmes could be derived.

PAE and (4) motivation, (5) PA, (6) motivation and PA

As expected with regard to the EVT (Atkinson, 1964), the motivation was associated with the PA patterns of the environment, thereby revealing that individuals show more motivation when the environment is more active.

Consistent with earlier findings, bivariate correlations based on the present data were significant for the motivation and to increase their physical activity patterns (Woods et al., 2007). Unfortunately, within the model, the motivation was not shown to have an impact on PA levels of children and adolescents. This effect seemed to be due to multicollinearity. Thus, the specific amount of motivation in itself seemed to be smaller than suggested by the bivariate correlations.

Children and adolescents with a more active environment were shown to be more active as well. This result is in accordance with Bandura's (1986) SCT and some earlier findings (Gustafson & Rhodes, 2006).

(7) SES, (8) PA and EPs

In accordance with earlier findings, the EPs of children and adolescents were poorer when SES was lower (Eikenberry & Smith, 2004). Contradicting earlier findings, there was no significant correlation between PA and EPs. Ordinarily, PA has been associated with behavioural processes characterizing or leading to better health (Wing et al., 2001).

(9) PA, (10) EPs and PF

Whereas PF is positively associated with PA, which is in agreement with earlier findings (Castelli & Valley, 2007), there was, in contrast to earlier findings (Chen et al., 2005), no association between EPs and PF.

(11) PA, (12) EPs, (13) PF and health

Earlier research has suggested an emerging body of evidence that at school age a lack of PA, a lack of

vegetable consumption and sugar-sweetened beverage consumption play important roles in the development of obesity as a health 'at-risk' factor (Coleman, Geller, Rosenkranz, & Dzewaltowski, 2008). The bivariate findings of the present data were significant for EPs and health, but not for PA and health, and not for PF and health as well. Inconsistent with earlier findings, better EPs were associated with poorer health. Neither PA, nor EPs, nor PF were shown to have an impact on health within the model. Thus, the relevance of the relationship of EPs to health seemed to decline if parts of the bivariate correlation were explained by PA and PF. However, even though there was a discrepancy in the significance levels, the difference between the scores for the path and the bivariate correlation for EPs and health was very small. The distribution of this relationship resembles a null correlation except for some participants with above-average EPs and below-average health. Maybe these were children or adolescents with a higher PF so that a higher energy intake is, at least, adequate. Further it could be that the answers were faked, or that they indeed overestimate or underestimate their energy intake.

(14) PF, (15) health and complaints

Finally, as expected (Eiberg et al., 2005), complaints were fewer for children and adolescents with better PF. Complaints were more frequent for those with better health, which was contradictory to expectations (Janssen et al., 2004). However, these results can be explained by the fact that symptoms are also often not related to a defined diagnosis (Garralda, 1992).

In summary, a five-level model providing more detailed information about the complex interplay of determinants of health behaviour and their consequences on health and complaints could be shown for complaints, but not for health. Fewer complaints were associated with higher levels of PF, higher PA levels, an active environment and a higher SES. Therefore, interventions can be implemented on levels 1 to 3 within the model.

Furthermore, the present analyses showed that such a holistic approach leads to different results compared to those of the bivariate analyses, emphasizing the meaning of holistic analyses in health research. We therefore suggest more holistical approaches to shed more light on this field of research.

However, for some relationships within the process model (e.g. the effect of SES on PA), it is not clear whether they are age-independent or not. In order to achieve adequate reliable estimates within the model, we chose not to reduce the sample size by considering the age groups. Further research with larger samples is needed to analyse differences for different age groups within holistic process models. Moreover, besides a reanalysis of the present model, to examine the stability of the results, further specifications of the model are needed. For example migration and milieu on level 1, quality of life and eating patterns of the parents on level 2, as well as sedentary behaviours on level 3 could provide further information for health promotion in children and adolescents.

References

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. Englewood Cliffs, NJ: Prentice-Hall.

Anderssen, N., & Wold, B. (1992). Parental and peer influences on leisure-time physical activity in young adolescents. *Research Quarterly for Exercise and Sport*, *63*, 341–348.

Antonovsky, A. (1979). *Health, stress and coping*. San Francisco, CA: Jossey-Bass.

Atkinson, J. W. (1964). *An introduction to motivation*. Oxford: Van Nostrand.

Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education and Behaviour*, *31*, 143–164.

Biddle, S. (1998). Sport and exercise motivation: A brief review of antecedent factors and psychological outcomes of participation. In K. Green & K. Hardman (Eds.), *Physical education: A reader* (pp. 154–183). Aachen, Germany: Meyer & Meyer.

Boreham, C., & Riddoch, C. (2001). Physical activity, physical fitness and children's health: Current concepts. In N. Amstrong & W. Mechelen (Eds.), *Paediatric exercise science and medicine* (pp. 244–250). Oxford: Oxford University Press.

Bös, K., Worth, A., Opper, E., Oberger, J., Romahn, N., Wagner, M., ... Woll, A. (2009). *Das Motorik-Modul: Motorische Leistungsfähigkeit und körperlich-sportliche Aktivität von Kindern und Jugendlichen in Deutschland* [*The motoric-module: Motor performance ability and physical activity of children and adolescent in Germany*]. Baden-Baden, Germany: Nomos-Verlag.

Bronfenbrenner, U., & Morris, P. A. (1988). The ecology of human developmental processes. In W. Damon & N. Eisenberg (Eds.), *The handbook of child psychology* (vol. 3, pp. 993–1027). New York: John Wiley & Sons.

Brunet, M., Chaput, J. P., & Tremblay, A. (2007). The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: The 'Québec en Forme' Project. *International Journal of Obesity*, *31*, 637–643.

Burke, V., Beilin, L. J., Durkin, K., Stritzke, W. G. K., Houghton, S., & Cameron, C. A. (2006). Television, computer use, physical activity, diet and fitness in Australian adolescents. *International Journal of Pediatric Obesity*, *1*, 248–255.

Castelli, D. M., & Valley, J. A. (2007). Chapter 3: The relationship of physical fitness and motor competence to physical activity. *Journal of Teaching in Physical Education*, *26*, 358–374.

Chen, X., Sekine M., Hamanishi, S., Wang, H., Gaina, A., Yamagami, T., & Kagamimori, S. (2005). Lifestyles and health-related quality of life in Japanese school children: A cross-sectional study. *Preventive Medicine*, *40*, 668–678.

Coleman, K. J., Geller, K. S., Rosenkranz, R. R., & Dzewaltowski, D. A. (2008). Physical activity and healthy eating in after-school environment. *Journal of School Health*, *78*, 633–640.

Currie, C., Gabhainn, S. N., Godeau, A., Roberts C., Smith, R., Currie, D., ... Barnekow, V. (2006). *Inequalities in young people's health. HBSC international report*. Copenhagen: WHO Regional Office for Europe.

Deflandre, A., Lorant, J., Gavarry, O., & Falgairette, G. (2001). Determinants of physical activity and physical and sports activities in French school children. *Perceptual and Motor Skills*, *92*, 399–414.

Dehghan, M., Akhtar-Danesh, N., & Merchant, A. T. (2005). Childhood obesity, prevalence and prevention. *Nutrition Journal*, *4*, 1–8.

Eiberg, S., Hasselstrom, H., Gronfeldt, V., Froberg, K., Cooper, A., & Andersen, L. B. (2005). Physical fitness as a predictor of cardiovascular disease risk factors in 6- to 7-year-old Danish children: The Copenhagen school-child intervention study. *Paediatric Exercise Science*, *17*, 161–170.

Eikenberry, N., & Smith, C. (2004). Healthful eating: Perceptions, motivations, barriers, and promoters in low-income Minnesota communities. *Journal of the American Dietetic Association*, *104*, 1158–1161.

Estabrooks, P. A., Lee, R. E., & Gyurcsik, N. C. (2003). Resources for physical activity participation: Does availability and accessibility differ by neighborhood socioeconomic status? *Annals of Behavioural Medicine*, *25*, 100–104.

Fletcher, A. C., Nickerson, P., & Wright, K. L. (2003). Structured leisure activities in middle childhood: Links to well-being. *Journal of Community Psychology*, *31*, 641–659.

Garralda, M. E. (1992). A selective review of child psychiatric syndromes with a somatic presentation. *British Journal of Psychiatry*, *161*, 759–733.

Gustafson, S. L., & Rhodes, R. E. (2006). Parental correlates of physical activity in children and early adolescents. *Sports Medicine*, *36*, 79–97.

Gutin, B., Yin, Z., Humphries, M. C., & Barbeau, P. (2005) Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. *American Journal of Clinical Nutrition*, *81*, 746–750.

Hanson, M. D., & Chen, E. (2007). Socioeconomic status and health behaviours in adolescence: A review of the literature. *Journal of Behavioural Medicine*, *25*, 425–438.

Janssen, I., Katzmarzyk, P. T., Boyce, W. F., & Pickett, W. (2004). The independent influence of physical inactivity and obesity on health complaints in 6th to 10th grade Canadian youth. *Journal of Physical Activity and Health*, *1*, 331–343.

Kamphuis, C. B., van Lenthe F. J., Giskes, K., Brug, J., & Mackenbach, J. P. (2007). Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands. *Health Place*, *13*, 493–503.

Krebs, N. F., Jacobson, M. S., Baker, R. D., Greer, F. R., Heyman, M. B., Jasic, T., & Lifshitz, F. (2003). Prevention of pediatric overweight and obesity. *Pediatrics*, *112*, 424–430.

Lämmle, L., Tittlbach, S., Oberger, J., Worth, A., & Bös, K. (2010, in press). A two-level model of motor performance ability. *Journal of Exercise Science and Fitness*, *8*.

Nigg, C. R., Borrello, B., Maddock, J., & Dishman, R. K. (2008). A theory of physical activity maintenance. *Applied Psychology*, *57*, 544–560.

O'Dea, J. A., & Wilson, R. (2006). Socio-cognitive and nutritional factors associated with body mass index in children and adolescents: Possibilities for childhood obesity prevention. *Health Education Research*, *21*, 796–805.

Public Authorities for Social Affairs, the Family and Consumer Protection. (2006). *Hamburger Kinder in Bewegung* [*Children in Hamburg in motion*]. Hamburg: Creativepool.

Riddoch, C., Savage, J. M., Murphy, N., Cran, G. W., & Boreham, C. (1991). Long term health implications of fitness and physical activity patterns. *Archives of Disease in Childhood*, *12*, 1426–1433.

Rimal, A. (2002). Associations of nutrition concerns and socioeconomic status with exercise habits. *International Journal of Consumer Studies*, *26*, 322–327.

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise*, *32*, 963–975.

Schäfer, H. (1978). Theorie der Risiken. In H. Schaefer & M. Blohmke (Eds.), *Handbuch der Sozialmedizin* [*Handbook of Social Medicine*] (pp. 176–243). Band 3. Stuttgart: Thieme.

Schmidt, W., Hartmann-Tews, I., & Brettschneider, W.-D. (2003). *Erster Deutscher Kinder und Jugendsportberich* [*First German children and adolescents sport report*]. Schorndorf, Germany: Hofmann.

Spiotta, R. T., & Luma, G. B. (2008). Evaluating obesity and cardiovascular risk factors in children and adolescents. *American Family Physician*, *78*, 1052–1058.

St-Onge, M.-P., Keller, K. L., & Heymsfield, S. B. (2003). Changes in childhood food consumption patterns: A

cause for concern in light of increasing body weights. *American Journal of Clinical Nutrition*, *78*, 1068–1073.

Taylor, D. O., & Horner, S. D. (2008). Collaborating with low-income families and their overweight children to improve weight related behaviours: An intervention process evaluation. *Journal for Specialists in Pediatric Nursing*, *13*, 263–274.

Treuth, M. S., Hou, N., Young, D. R. & Mayland, L. M. (2005). Validity and reliability of the Fels Physical Activity Questionnaire for Children. *Medicine and Science in Sports and Exercise*, *37*, 448–495.

US Department of Health and Human Services. (2000). *Healthy people 2010*. Office of Disease Prevention and Health Promotion. www.healthypeople.gov (accessed 6 April 2009).

Voss, L. D., Hosking, J., Metcalf, B. S., Jeffery, A. N., & Wilkin, T. J. (2008). Children from low-income families have less access to sports facilities, but are no less physically active: Cross-sectional study (EarlyBird 35). *Child Care, Health and Development*, *34*, 470–474.

Wang, L. Y., Gutin, B., Barbeua, P., Moore, J. B., Hanes, J., Johnson, M. H., ... Yin, Z. (2008). Cost-effectiveness of a school-based obesity prevention program. *Journal of School Health*, *78*, 619–624.

Wing, R. R., Goldstein, M. G., Acton, K. J., Birch, L. L., Jakicic, J. M., Sallis, J. F., Jr, ... Surwit, R. S. (2001). Behavioural science research in diabetes: Lifestyle changes related to obesity, eating behaviour, and physical activity. *Diabetes Care*, *24*, 117–123.

Winster, A. V. (1996). The effects of socioeconomic status on exercise and smoking. *Journal of Aging and Health*, *8*, 467–489.

Wold, B., & Hendry, L. (1998). Social and environmental factors associated with physical activity in young people. In S. Biddle, J. Sallis, & N. Cavill (Eds.), *Young and active? Young people and health-enhancing physical activity: Evidence and implications* (pp. 119–132). London: Health Education Authority.

Woods, A. M., Bolton, K. N., Graber, K. C., & Crull, G. S. (2007). Chapter 5: Influence of perceived motor competence and motives on children's physical activity. *Journal of Teaching in Physical Education*, *26*, 390–403.

World Health Organization (WHO). (2004). *WHO global strategy on diet, physical activity and health*. Geneva: Fifty-Seventh World Health Assembly.

Yan, J. H., & McCullagh, P. (2004). Cultural influences on youth's motivation of participation in physical activity. *Journal of Sport Behaviour*, *27*, 378–390.

Ziviani, J., Wadley, D., Ward, H., Macdonald, D., Jenkins, D., & Rodger, S. (2008). A place to play: Socioeconomic and spatial factors in children's physical activity. *Australian Occupational Therapy Journal*, *55*, 2–11.

Author biographies

LENA LÄMMLE is currently working as a lecturer in Department of Sports Psychology at the Technische Universität München. Her interests focus on health and sport psychology.

ANNETTE WORTH is a Professor at the Division of Public Health at the Pädagogische Hochschule Schwäbisch Gmünd. Her research interests include physical fitness and exercise.

KLAUS BÖS is a Professor in the Division of Sport and Sport Sciences in the Department of Philosophy, Universität Karlsruhe (TH). His main areas of interest are physical fitness and exercise.