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ORIGINAL ARTICLE

Main meal frequency measures in the Health Behaviour in School-aged Children study: agreement with 7-day 24-h recalls

Trine Pagh Pedersen · Bjørn E. Holstein · Bjarne Laursen · Mette Rasmussen

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Abstract
Objectives To estimate agreement between questionnaire-based frequency measures from the Health Behaviour in School-aged Children study (HBSC) and 7-day 24-h recall measures of breakfast, lunch and evening meals among 11–15-year-olds, and examine whether disagreement between the two methods varied by socio-demographic factors.
Methods In one week 11–15-year-old Danish students completed HBSC questionnaires including meal frequency items. The following week they completed daily 24-h recall questionnaire about their meals (response rate 88.4 %, $n = 412$).
Results Good to moderate agreement for the breakfast measure: per cent agreement 0.70–0.87, kappa 0.43–0.65. Fair agreement for the lunch measure: per cent agreement 0.53–0.84, kappa 0.26–0.54. High per cent agreement for the evening meal measure (0.83–0.95) but poor kappa agreement (0.14–0.19). Being immigrant predicted disagreement between the two methods for week day breakfast OR (95 % CI) 2.17 (1.16–4.04) and lunch 2.44 (1.33–4.48).
Conclusions We found good to moderate agreement between frequency and 7-day 24-h recall measures for breakfast, a fair agreement for lunch and for evening meal the two agreement methods provided different results. Migration status predicted disagreement between the two methods.

Keywords Adolescents · Agreement · Main meal frequency · Frequency measures · 24-h recall measures

T. P. Pedersen (✉) · B. E. Holstein · B. Laursen · M. Rasmussen
National Institute of Public Health, University of Southern Denmark, Øster Farimagsgade 5, 1353 Copenhagen K, Denmark
e-mail: Tppe@niph.dk

B. E. Holstein
e-mail: Bho@niph.dk

B. Laursen
e-mail: Bla@niph.dk

M. Rasmussen
e-mail: Mera@niph.dk

Introduction

Infrequent meal consumption is increasingly being considered a public health issue because of its associations with poor nutritional intake (Nicklas et al. 2001; Pedersen et al. 2012; Rampersaud et al. 2005; Sjöberg et al. 2003; Storey et al. 2009). Also, the literature indicates that infrequent meal consumption is associated with overweight among adolescents (Fabritius and Rasmussen 2008; Koletzko and Toschke 2010; Nicklas et al. 2001; Rampersaud et al. 2005; Toschke et al. 2005). According to Pereira et al. (2011) breakfast consumption may increase satiety, resulting in reduced energy intake and thereby lower the risk of developing overweight/obesity (Pereira et al. 2011). The existing literature also suggests an association between infrequent breakfast consumption and poor ability to concentrate among adolescents (Cooper et al. 2011; Hoyland et al. 2009; Rampersaud et al. 2005). From a prevention perspective, it is important to know whether a particular health behaviour in childhood and adolescence predicts similar behaviour in adulthood. The existing literature documents that main meal frequencies in adolescence predict main meal frequencies in adulthood (Pedersen et al. 2013).

Measures of main meal frequency such as breakfast, lunch and evening meal among adolescents are broadly used in population surveys such as the Health Behaviour in School-aged Children study (HBSC). Increasing our understanding of the validity of measures for estimating adolescents' meal habits is important to ensure that associations identified in studies of adolescent meal habits are not due to misclassifications of the applied measure of meal habits. Only few studies address the validity of the applied measures. Whereas a number of studies compare self-reported frequency of consuming specific food-items with 24-h recall-data and diet records (Haraldsdottir et al. 2005; Rockett et al. 2003; Vereecken et al. 2008, 2010; Vereecken and Maes 2003), we have only identified three studies which compare measures of main meal consumption. One study by Persson Osowski et al. (2012) among Swedish 10–12-year-olds found a moderate agreement between children's report of breakfast, lunch and evening meal frequency compared to parents' reports of their children's meal frequency (Persson Osowski et al. 2012). Sjöberg and Hulthén (2004) compared a diet history and a 7-day record with regard to frequency of main meals among Swedish 15–16-year-old girls. They found the best agreement for breakfast (86 % had identical frequency, lunch 69 %, and dinner 67 %) (Sjöberg and Hulthén 2004). The HBSC breakfast frequency measure has been validated in a test–retest and 7-day diary among 11–15-year-olds in Flanders, Finland and Italy. Test–retest kappa statistics of daily consumers versus less than daily consumers were good (Flanders: week 0.71; weekend 0.60; Italy: week 0.71; weekend (not reported); Finland: week 0.78; weekend 0.58). Kappa statistics comparing daily consumption of breakfast to diary measures in the Flemish population were fair for weekends (0.34) and moderate for weekdays (0.47) (Vereecken et al. 2014).

Meal habits vary by socio-demographic factors (Pearson et al. 2009; Pedersen et al. 2012; Sjöberg et al. 2003; Utter et al. 2010) and it is important to examine whether there are socio-demographic variations in agreement. We have not been able to identify studies of this issue.

The aim of this study was therefore to (1) investigate agreement between the HBSC questionnaire-based main meal frequency measures and a 7-day 24-h recall measures of breakfast, lunch and evening meals among 11–15-year-olds, and (2) examine whether disagreement between the frequency and 24-h recall methods varied by socio-demographic factors.

Methods

This study is part of "The Meal Habits Validation Study" which is part of the on-going validation procedures including qualitative and quantitative studies within the cross-national Health Behaviour in School-aged Children (HBSC) study (Currie et al. 2009). The Health Behaviour in School-aged Children (HBSC) study is a cross-national and cross-sectional WHO collaborative study. The overall aim of the study is to monitor and describe young people's health and health behaviours and to gain further understanding of how health and behaviour relate to social contexts (Currie et al. 2009). Data collection is conducted every 4th year among students aged 11, 13 and 15 years (in Denmark, equivalent to 5th, 7th and 9th grade) in a random sample of schools (i.e., cluster sampling). The students complete the self-administered, internationally standardised, and anonymous HBSC questionnaire at school (Roberts et al. 2009). In the absence of a golden standard for measuring main meal frequencies we compared the HBSC questionnaire-based main meal frequency measures with a 7-day 24-h recall questionnaire. Data collection for the present study was conducted in Denmark during the autumn 2012.

The first step was to pilot test the 24-h recall questionnaire in one 5th grade, one 7th grade, and one 9th grade class in one school, corresponding to the age groups 11-, 13-, and 15-year-olds. During one week the students completed the 24-h recall questionnaire every school day. The 24-h recall questionnaire and the procedure were adjusted according to minor comments from the students and teachers.

The second step was the main study "The Meal Habit Validation Study" which took place in two strategically selected schools, one school from a rural and medium socio-economic area with low proportion of immigrants and descendants of immigrants, and one school from an urban and low socio-economic area with a high proportion of immigrants. We included all students in 5th, 6th, 7th and 9th grade (21 classes). The students were asked to complete a web-based version of the internationally standardised HBSC questionnaire at school in one week (Roberts et al. 2009).

The following week they were each day asked to think of the previous day and fill in a 24-h recall paper-version questionnaire in their school class. To obtain data from the weekend the students were on the first day Monday asked to fill out for Friday, Saturday and Sunday. This approach was chosen due to feasibility of the study. We invited 466 students to participate. Six students were excluded due to request by parents. In total, 425 students responded to the questionnaire, response rate 425/466 = 91.2 %. Of the 466 students invited 438 returned the 24-h recall questionnaire, response rate 438/466 = 94.0 %. We had a comparable match of 412 students with questionnaire and 24-h recall data available, response rate = 412/466 = 88.4 %. The validation study comprised 103 5th graders (mean age

11.3, SD = 0.4), 121 6th graders (mean age 12.4, SD = 0.4), 102 7th graders (mean age 13.4, SD = 0.4) and 86 9th graders (mean age 14.9, SD = 0.5). Total mean age was 13.0 (SD = 1.5).

In Denmark, there is no ethical agency for approval of non-invasive studies such as questionnaire-based studies in the general population. Instead we asked for approval by the school headmasters. Further, we informed parents about the study and they had the opportunity to withdraw their child from the study by returning a withdrawal note. The students were informed that participation was voluntary and anonymous. The study is completely anonymous as the data file does not contain data which can be traced back to individual students. Managing and storage of data are approved by the Danish Data Protection Agency (Ref 2013-54-0461).

Measures

The meal frequency items in the HBSC questionnaire were formulated separately for weekdays and weekend: "On weekdays/weekend: How often do you usually eat breakfast (more than a glass of milk or juice)/lunch (a proper meal in the middle of the day)/evening meal (a proper meal in the evening)". The response categories were for weekdays: "I never eat breakfast/lunch/evening meal in the weekdays", "One day", "Two days", "Three days", "Four days", "Five days". For weekend: "I never eat breakfast/lunch/evening meal in the weekend", "Breakfast/lunch/evening meal one day in the weekend", "Breakfast/lunch/evening meal both Saturday and Sunday". We use the term "frequency" about these measures in the manuscript.

The 24-h recall questionnaire included the following questions: "Did you have breakfast (more than a glass of milk or juice)/lunch (a proper meal in the middle of the day)/an evening meal (a proper meal in the evening) yesterday". Response categories were yes and no. We use the term "24-h recall measures" about these measures in the manuscript. To compare the frequency measures with the 24-h recall measures the 24-h recall measures were categorized into "Never eat breakfast/lunch/evening meal in the weekdays", "One day", "Two days", "Three days", "Four days", "Five days". For weekend: "Never eat breakfast/lunch/evening meal in the weekend", "Breakfast/lunch/evening meal one day in the weekend", "Breakfast/lunch/evening meal both Saturday and Sunday". In the agreement analyses of e.g., weekday breakfast only students who had answered the 24-h recall breakfast for all 5 weekdays were included in the agreement analyses and the same procedure was used for the other meal types. In the analyses of agreement between frequency measures and 24-h recall measures we compared the ordinal measures and two dichotomizations: "Daily" versus "Not daily" and "Three days or less" versus "Four or more days". Table 1 shows the response categories and response distribution.

In the disagreement analyses we constructed variables of disagreement (yes/no) for the dichotomized daily versus not daily meal measures.

Prior to the present quantitative part of "The Meal Habits Validation Study" we conducted a qualitative part. Hereby face and content validity of the frequency items were tested in a qualitative validation study among students in three age groups (11-, 13- and 15 year olds). In total we conducted 20 gender divided focus groups at five schools with 2–5 students in each group. The objective was to learn about the students' perceptions and experiences of the measures immediately after they had answered the questionnaire. Further, to understand how they understood the concepts breakfast, lunch and evening meal. We found generally high face validity as the students found it easy to answer the items and the terms breakfast and evening meal were generally used concepts. For some few it was difficult to define the term lunch. To clarify the content validity the students were asked about the concept of a proper meal for lunch and evening meal. In general the students found it more difficult to define a proper meal for lunch than for evening meal. The students mentioned both healthy and unhealthy foods and good tasting, but in general the students answered that a proper meal had to make you full (unpublished report from the qualitative part of the study).

The analyses included four socio-demographic variables as predictors of disagreement: gender, grade, family social class and migration status. According to prior studies, these variables are associated with meal frequency (Pedersen et al. 2012; Sjöberg et al. 2003; Utter et al. 2010). Family social class was measured by the students' information about parents' occupation. The research group coded the information according to the standards of the Danish National Institute of Social Research (Christensen et al. 2014; Hansen 1986) which is almost identical to the UK Registrar General's classification (Galobardes et al. 2006). We categorised the students by the highest ranking parent into: high family social class (social classes I + II), medium (III + IV), low (V + economically inactive), and missing/non-classifiable. The measure of migration was constructed from the respondents' reports of their own and their parents' country of birth, categorised into natives and immigrants/descendants of immigrants (Table 2).

Statistical analysis

We used SAS statistical software package (v. 9.3, SAS Institute, Cary NC, USA). We defined agreement as using completely comparable categories and applied three agreement measures for the variables presented in Table 1: (1) Per cent agreement calculated from the cross-tabulation.

(2) Weighted kappa (Cicchetti-Allison's weighting method) for variables with ordinal categories. (3) Kappa for the dichotomized variables. Per cent agreement and kappa statistics provide different information about agreement. The kappa coefficient takes into account the agreement expected by chance, which is not the case for the percentage agreement (Altman 1991), but the kappa coefficients are misleading in case of asymmetric appearance of disagreement (Cicchetti and Feinstein 1990; Fayers and Machin 2007; Feinstein and Cicchetti 1990). We therefore apply both approaches to complement each other. We applied the Altman guidelines (slightly adapted from Landis and Koch 1977) for interpretation of kappa coefficients: 0.81–1.00 very good, 0.61–0.80 good, 0.41–0.60 moderate, 0.21–0.40 fair and <0.21 poor (Altman 1991; Landis and Koch 1977). The agreement analyses were conducted for the total sample and stratified on gender and age.

Analyses of missing values were conducted by chi^2 test comparing respondents and non-respondent on the main meal frequency measures with respondents and non-respondent on the 24-h recall main meal measures.

In the disagreement analyses we used univariate logistic regression to investigate how disagreement varied by socio-demographic factors. We used the socio-demographic variables as predictors for disagreement between the two methods and modelled against disagreement for breakfast weekday, breakfast weekend, lunch weekday, lunch weekend, evening meal weekday and evening meal weekend. Generally, we used multilevel analyses to account for the cluster-design of the study (students within school classes and classes within schools). In few of the analyses the model did not converge and these analyses were conducted without the random effects of school class and school. Table 2 shows the proportion of students with disagreement.

Results

Table 1 shows per cent agreement, kappa, and weighted kappa. The level of agreement varied by variable and applied agreement measure. The breakfast measure had high per cent agreement (range 0.70–0.87) and good to moderate kappa agreement (range 0.43–0.65). For lunch the per cent agreement was medium (range 0.53–0.84) and kappa agreement fair (range 0.26–0.54). The evening meal measure had a high per cent agreement (range 0.83–0.95) while the kappa agreement was poor (range 0.14–0.19). The agreement was better for the dichotomized than the ordinal variables. The highest per cent agreement was found for evening meal (0.95). The lowest per cent agreement was found for ordinal data on lunch in weekends (0.53). Gender and age stratified analyses showed similar patterns (data not shown). Table 1 also shows proportion of missing responses. Missing was highest in the 24-h recall questionnaire and especially for lunch in weekdays (23.3 %). Analyses of missing data showed that a significant larger proportion of adolescents with missing 24-h recall data reported not eating breakfast (18.8 %, $p = 0.022$) and evening meal (35.3 %, $p = 0.006$) every weekday in the frequency measure compared to adolescents with data available.

Table 2 illustrates the distribution of the included socio-demographic variables. Table 2 also illustrates the proportion of adolescents with disagreement between frequency and 24-h-recall measures by socio-demographic variables. The proportion of disagreement for weekday and weekend lunch is high among immigrants (38.2 and 42.9 %).

Table 3 presents the results of the disagreement analyses. Socio-demographic predictors for the disagreement between the two methods are illustrated for each meal type. Adolescents with missing data on family social class had higher odds for disagreement on breakfast in the weekdays compared to adolescents from high social class (OR, CI 95 % 2.51, 1.13–5.54). Further, immigrants had higher odds for disagreement on breakfast and lunch in the weekdays compared to natives (OR, CI 95 %. breakfast 2.98, 1.45–6.11, lunch 2.48, 1.08–5.70).

Discussion

The present agreement study of breakfast, lunch and evening meal measures presents a good to moderate agreement between HBSC frequency measures and 24-h recall measures with regard to breakfast and a fair agreement for lunch. For evening meal we found high per cent agreement and low kappa. The agreement between frequency data and 24-h recall data was better for dichotomous than ordinal variables and differed by agreement method used. The existing agreement studies on meal measures differ in methods and measures. Sjöberg and Hulthén (2004) compared a diet history and a 7-day record with regard to frequency of main meals among Swedish 15–16-year-old girls and found a similar pattern of per cent agreement as found in our study (Sjöberg and Hulthén 2004). The HBSC breakfast frequency measure was previously validated by a 7-day diary among 11–15-year-olds in Flanders. Their agreement was poor compared to our study (Vereecken et al. 2014). The methods applied in the Flanders study are briefly described, and comparisons with the methods applied in the present study are therefore difficult. Our results indicate that students may find the lunch measure difficult to define whereas breakfast and evening meal measures might be easier to interpret. This could be due to the setting of the different meals. Breakfast and evening

Table 1 Distribution of main meal variables and agreement analyses of frequency and 24-h recall measures, Denmark 2012

	Frequency main meal measure *N* (%)	24-h recall main meal measure *N* (%)	Categorizations applied in analyses of agreement	Per cent agreement	Weighted kappa/ kappa (95 % CI)
Breakfast weekday, $n = 358$					
Never	50 (12.1)	28 (6.8)	All categories (ordinal)	0.70	0.63 (0.56–0.70)
One day	14 (3.4)	20 (4.9)			
Two days	18 (4.4)	16 (3.9)			
Three days	24 (5.8)	24 (5.8)			
Four days	22 (5.3)	31 (7.5)	4–5 days versus 0–3 days	0.87	0.65 (0.56–0.74)
Five days	283 (68.7)	239 (58.0)	Daily versus not daily	0.84	0.62 (0.53–0.70)
Missing	1 (0.2)	54 (13.1)			
Breakfast weekend, $n = 379$					
Never	10 (2.4)	17 (4.1)	All categories (ordinal)	0.85	0.43 (0.31–0.54)
One day	36 (8.7)	48 (11.7)			
Two days	348 (84.5)	332 (80.6)	Daily versus not daily	0.87	0.46 (0.33–0.59)
Missing	18 (4.4)	15 (3.6)			
Lunch weekday, $n = 313$					
Never	25 (6.1)	9 (2.2)	All categories (ordinal)	0.54	0.35 (0.27–0.42)
One day	13 (3.2)	17 (4.1)			
Two days	25 (6.1)	17 (4.1)			
Three days	38 (9.2)	20 (4.9)			
Four days	47 (11.4)	50 (12.1)	4–5 days versus 0–3 days	0.84	0.54 (0.42–0.65)
Five days	261 (63.4)	203 (49.3)	Daily versus not daily	0.71	0.37 (0.26–0.47)
Missing	3 (0.7)	96 (23.3)			
Lunch weekend, $n = 379$					
Never	59 (14.3)	85 (20.6)	All categories (ordinal)	0.53	0.26 (0.18–0.34)
One day	116 (28.2)	100 (24.3)			
Two days	222 (53.9)	208 (50.5)	Daily versus not daily	0.65	0.29 (0.19–0.38)
Missing	15 (3.6)	19 (4.6)			
Evening meal weekday, $n = 342$					
Never	6 (1.5)	0 (0.0)	All categories (ordinal)	0.83	0.14 (0.03–0.24)
One day	2 (0.5)	2 (0.5)			
Two days	5 (1.2)	2 (0.5)			
Three days	3 (0.7)	8 (1.9)			
Four days	18 (4.4)	36 (8.7)	4–5 days versus 0–3 days	0.95	0.15 (−0.07–0.38)
Five days	375 (91.0)	297 (72.1)	Daily versus not daily	0.85	0.19 (0.05–0.32)
Missing	3 (0.7)	67 (16.3)			
Evening meal weekend, $n = 376$					
Never	3 (0.7)	5 (1.2)	All categories (ordinal)	0.90	0.17 (−0.01–0.34)
One day	8 (1.9)	31 (7.5)			
Two days	384 (93.2)	357 (86.7)	Daily versus not daily	0.90	0.15 (−0.01-0.30)
Missing	17 (4.1)	19 (4.6)			

Agreement is defined as using completely comparable categories

Table 2 Distribution of socio-demographic variables and per cent disagreement between frequency and 24-h recall main meal measures, Denmark 2012

	N (%)	Disagreement breakfast weekdays (yes) *N* (%)	Disagreement breakfast weekend (yes) *N* (%)	Disagreement lunch weekdays (yes) *N* (%)	Disagreement lunch weekend (yes) *N* (%)	Disagreement evening meal weekdays (yes) *N* (%)	Disagreement evening meal weekend (yes) *N* (%)
Gender							
Girls	200 (51.5)	24 (13.8)	20 (10.7)	44 (29.0)	67 (36.0)	25 (14.8)	16 (8.7)
Boys	212 (48.5)	35 (19.0)	29 (15.1)	47 (29.2)	67 (34.7)	27 (15.6)	20 (10.4)
Age group							
11-year-olds	103 (25.0)	14 (16.7)	7 (8.0)	16 (23.2)	36 (40.5)	9 (11.5)	9 (9.7)
12-year-olds	121 (29.4)	21 (19.3)	12 (10.7)	33 (34.7)	31 (27.9)	13 (12.4)	8 (7.5)
13-year-olds	102 (24.8)	11 (12.5)	13 (13.5)	23 (30.3)	32 (33.7)	14 (17.3)	9 (9.7)
15-year-olds	86 (20.9)	13 (16.9)	17 (20.5)	19 (26.0)	35 (41.7)	16 (20.5)	10 (12.1)
Family social class							
High	102 (24.8)	13 (13.7)	15 (15.2)	23 (26.4)	35 (36.1)	18 (19.4)	6 (6.3)
Medium	148 (35.9)	16 (12.6)	16 (11.5)	37 (33.0)	46 (32.2)	19 (15.3)	16 (11.5)
Low	77 (18.7)	10 (15.6)	9 (12.9)	14 (25.0)	29 (42.7)	9 (14.8)	7 (10.3)
Missing	85 (20.6)	20 (27.8)	9 (12.7)	17 (29.3)	24 (33.8)	6 (9.4)	7 (9.6)
Migration status							
Natives	355 (86.2)	44 (14.2)	38 (11.5)	78 (28.0)	113 (34.2)	43 (14.5)	31 (9.5)
Immigrants	57 (13.8)	15 (31.9)	11 (22.9)	13 (38.2)	21 (42.9)	9 (19.6)	5 (10.0)

Disagreement for the dichotomized variables daily versus not daily

Table 3 Unadjusted OR (95 % CI) for disagreement between frequency and 24-h recall main meal measures by socio-demographic predictors, Denmark 2012

	Breakfast weekdays OR (95 % CI)	Breakfast weekend OR (95 % CI)	Lunch weekdays OR (95 % CI)	Lunch weekend OR (95 % CI)	Evening meal weekdays OR (95 % CI)	Evening meal weekend OR (95 % CI)
Gender						
Girls	1.00	1.00	1.00	1.00	1.00	1.00
Boys	1.47 (0.83–2.61)	1.59 (0.84–3.01)	0.97 (0.59–1.59)	0.95 (0.62–1.45)	1.07 (0.60–1.93)[a]	1.22 (0.61–2.44)[a]
Age group						
11-year-olds	1.00	1.00	1.00	1.00	1.00	1.00
12-year-olds	1.18 (0.46–3.01)	1.19 (0.33–4.27)	1.67 (0.68–4.08)	0.57 (0.30–1.11)	1.96 (0.74–5.20)	0.75 (0.25–2.25)
13-year-olds	0.72 (0.26–2.01)	1.62 (0.43–6.07)	1.41 (0.55–3.59)	0.75 (0.38–1.48)	1.60 (0.60–4.30)	0.99 (0.33–2.94)
15-year-olds	1.02 (0.37–2.80)	2.47 (0.67–9.16)	1.15 (0.45–2.97)	1.05 (0.53–2.08)	1.07 (0.40–2.85)	1.27 (0.43–3.73)
Family social class						
High	1.00	1.00	1.00	1.00	1.00	1.00
Medium	0.91 (0.41–2.02)	0.70 (0.32–1.55)	1.30 (0.69–2.44)	0.85 (0.49–1.47)	0.76 (0.37–1.55)	1.95 (0.73–5.20)
Low	1.20 (0.49–2.97)	0.84 (0.33–2.13)	0.96 (0.44–2.09)	1.33 (0.70–2.53)	0.71 (0.29–1.71)	1.72 (0.55–5.39)
Missing	2.51 (1.13–5.54)	0.80 (0.31–2.06)	1.24 (0.58–2.63)	0.91 (0.47–1.74)	0.42 (0.16–1.13)	1.59 (0.51–4.98)
Migration status						
Natives	1.00	1.00	1.00	1.00	1.00	1.00
Immigrants	2.98 (1.45–6.11)	1.44 (0.61–3.41)	2.48 (1.08–5.70)	1.43 (0.77–2.67)	1.42 (0.63–3.16)	1.06 (0.39–2.87)[a]

Disagreement for the dichotomized variables daily versus not daily

[a] Logistic regression without random effects of school and school class

meal are often consumed in the home and lunch could be consumed in different settings such as the e.g., the home or school. Further, we found that immigrants had higher odds of disagreement than native adolescents. To our knowledge, no other studies of socio-demographic predictors for disagreement have previously been published. Our findings suggest that the understanding of questions or meal culture may be different among native Danish adolescents and immigrants. Additional research involving analyses of both qualitative and quantitative data is needed to examine the exact reasons underlying the difference in agreement by immigrant status.

There is no golden standard for measuring meal frequencies and this study compare frequency measures with 7-day 24-h recall measures. The lack of agreement between the two methods for some of the measures could therefore be due to limitations of both methods. The present study would have benefitted from 24-h recall data covering more than 7 days thereby providing a better measure of habits. In line with previous studies (Sjöberg and Hulthén 2004; Vereecken et al. 2014) and due to the feasibility of the study we chose the 7-day approach as 7 days reflect a normal week.

Per cent agreement and kappa statistics provide different information about agreement. The advantage of the kappa coefficient is that it takes into account the agreement expected by chance. One example is the findings regarding evening meal: few adolescents skip this meal and their reporting of the meal is similar in both methods. Therefore the observations are mainly placed in one cell. Consequently, the per cent agreement was high but some of this high agreement appears by chance. The kappa coefficients are however misleading in case of asymmetric appearance of disagreement (Cicchetti and Feinstein 1990; Fayers and Machin 2007; Feinstein and Cicchetti 1990). The guidelines for interpretation of kappa coefficients have been criticized for being arbitrary but they are commonly used (Fayers and Machin 2007).

Generally we found more missing data in the 24-h recall data than in the meal frequency data. This observation could suggest that completing the 24-h recall questionnaire is time demanding and that adolescents may find it easier to report a habit in a frequency questionnaire.

The participants' interpretation of the term 'meal' may compromise the validity of the study. Adolescents tend to snack more and may be subject to constant eating rather than eating meals, although this does not seem to be the case for Danish adolescents (Lund and Gronow 2014). Also, our initial qualitative observations suggest no such significant problems. Still, our results indicate that the term "meal" may be interpreted differently depending of migration status.

The current agreement study have been conducted among Danish adolescents but the HBSC main meal measures have been developed in the international HBSC study and are suitable for capturing meal habits internationally.

The present study has a relatively large study population which covers the age range from 11 to 15 years. The response rate was high, and the socio-economic composition of the study population was diverse and therefore appropriate for the study of socio-demographic variations.

Future research would benefit from qualitative validation studies exploring the perception of the term meal among adolescents characterised by different socio-demographic profiles. Such qualitative studies would help clarify adolescents' definitions of a proper meal. Future validation efforts should also include observational studies comparing agreement between observations at school with questionnaire frequency measures.

Conclusions

We found a good to moderate agreement between the HBSC frequency measures and 24-h recall measures for breakfast and a fair agreement for lunch. For evening meal we found a high per cent agreement. Immigrants had higher odds of disagreement between the two methods than native Danes. Until more insight into the validation of meal frequency measures is available, we recommend the use of questionnaire based meal frequency measures.

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Compliance with ethical standards

Conflict of interest None of the authors have any conflicts of interest.

References

Altman DG (1991) Practical statistics for medical researchvol Reprint. Chapman and Hall/CRC, London

Christensen U, Krølner R, Nilsson CJ et al (2014) Addressing social inequality in aging by the Danish occupational social class measurement. J aging health 26:106–127. doi:10.1177/0898264314522894

Cicchetti DV, Feinstein AR (1990) High agreement but low kappa: II. Resolving the paradoxes. J clin epidemiol 43:551–558

Cooper SB, Bandelow S, Nevill ME (2011) Breakfast consumption and cognitive function in adolescent school children. Physiol Behav 103:431–439. doi:10.1016/j.physbeh.2011.03.018

Currie C, Nic GS, Godeau E (2009) The health behaviour in school-aged children: WHO collaborative cross-national (HBSC) study: origins, concept, history and development 1982–2008. Int J Public Health 54(2):131–139

Fabritius K, Rasmussen M (2008) [Breakfast habits and overweight in Danish school children. The role of socioeconomic positions]. UgeskrLaeger 170:2559–2563

Fayers PM, Machin D (2007) Quality of life: the assessment, analysis and interpretation of patient-reported outcomes vol, 2nd edn. John Wiley, Chichester

Feinstein AR, Cicchetti DV (1990) High agreement but low kappa: I. The problems of two paradoxes. J clin epidemiol 43:543–549

Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G (2006) Indicators of socioeconomic position (part 2). J Epidemiol Community Health 60:95–101. doi:10.1136/jech.2004.028092

Hansen EJ (1986) The living circumstances of the Danish People—1986 compared to 1976: an interview study of 4500 Danish people. Hans Reitzels publisher, Copenhagen

Haraldsdottir J, Thorsdottir I, de Almeida MD, Maes L, Perez RC, Elmadfa I, Frost AL (2005) Validity and reproducibility of a precoded questionnaire to assess fruit and vegetable intake in European 11–12-year-old schoolchildren. Ann Nutr Metab 49:221–227

Hoyland A, Dye L, Lawton CL (2009) A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. Nutr Res Rev 22:220–243

Koletzko B, Toschke AM (2010) Meal patterns and frequencies: do they affect body weight in children and adolescents? Crit Rev Food Sci Nutr 50:100–105

Landis JR, Koch GG (1977) The measurement of observer agreement for categorical data. Biometrics 33:159–174

Lund TB, Gronow J (2014) Destructuration or continuity? The daily rhythm of eating in Denmark, Finland, Norway and Sweden in 1997 and 2012. Appetite 82:143–153. doi:10.1016/j.appet.2014.07.004

Nicklas TA, Baranowski T, Cullen KW, Berenson G (2001) Eating patterns, dietary quality and obesity. J Am Coll Nutr 20:599–608

Pearson N, Biddle SJ, Gorely T (2009) Family correlates of breakfast consumption among children and adolescents: a systematic review. Appetite 52:1–7

Pedersen TP, Meilstrup C, Holstein BE, Rasmussen M (2012) Fruit and vegetable intake is associated with frequency of breakfast, lunch and evening meal: cross-sectional study of 11-, 13-, and 15-year-olds. Int J Behav Nutr Phys Act 9:9. doi:10.1186/1479-5868-9-9

Pedersen TP, Holstein BE, Flachs EM, Rasmussen M (2013) Meal frequencies in early adolescence predict meal frequencies in late adolescence and early adulthood. BMC Public Health 13:445. doi:10.1186/1471-2458-13-445

Pereira MA, Erickson E, Mckee P, Schrankler K, Raatz SK, Lytle LA, Pellegrini AD (2011) Breakfast frequency and quality may affect glycemia and appetite in adults and children. J Nutr 1:163–168

Persson Osowski C, Fjellstrom C, Olsson U, Goranzon H (2012) Agreement between child and parent reports of 10–12-year-old children's meal pattern and intake of snack foods. J Hum Nutr Diet 25:50–58. doi:10.1111/j.1365-277X.2011.01169.x

Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD (2005) Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. J Am Diet Assoc 105:743–760

Roberts C et al (2009) The health behaviour in school-aged children (HBSC) study: methodological developments and current tensions. Int J Public Health 54(2):140–150

Rockett HR, Berkey CS, Colditz GA (2003) Evaluation of dietary assessment instruments in adolescents. Curr Opin Clin Nutr Metab Care 6:557–562

Sjöberg A, Hulthén L (2004) Assessment of habitual meal pattern and intake of foods, energy and nutrients in Swedish adolescent girls: comparison of diet history with 7-day record. Eur J Clin Nutr 58:1181–1189. doi:10.1038/sj.ejcn.1601947

Sjöberg A, Hallberg L, Höglund D, Hulthén L (2003) Meal pattern, food choice, nutrient intake and lifestyle factors in The Goteborg Adolescence Study. Eur J Clin Nutr 57:1569–1578

Storey KE, Hanning RM, Lambraki IA, Driezen P, Fraser SN, McCargar LJ (2009) Determinants of diet quality among Canadian adolescents. Can J Diet Pract Res 70:58–65

Toschke AM, Kuchenhoff H, Koletzko B, von Kries R (2005) Meal frequency and childhood obesity. Obes Res 13:1932–1938

Utter J, Denny S, Crengle S, Ameratunga S, Clark T, Maddison R, Percival T (2010) Socio-economic differences in eating-related attitudes, behaviours and environments of adolescents. Public Health Nutr:1–6. doi:10.1017/S1368980010001898

Vereecken CA, Maes L (2003) A Belgian study on the reliability and relative validity of the health behaviour in school-aged children food-frequency questionnaire. Public Health Nutr 6:581–588

Vereecken CA, Rossi S, Giacchi MV, Maes L (2008) Comparison of a short food-frequency questionnaire and derived indices with a seven-day diet record in Belgian and Italian children. Int J Public Health 53:297–305

Vereecken CA, de Bourdeaudhuij I, Maes L (2010) The HELENA online food frequency questionnaire: reproducibility and comparison with four 24-h recalls in Belgian-Flemish adolescents. Eur J Clin Nutr 64:541–548

Vereecken C, Kelly C, Ahluwalia N, Niclasen B, Pedersen TP (2014) Eating Habits. In: Currie C et al. (ed) Health behaviour in school-aged children (HBSC) study protocol: background methodology and mandatory items for the 2013/14 survey. Edinburgh: Health Behaviour in School-aged Children (HBSC) Network 2014