Public Health Nutrition: 15(1), 97–109 doi:10.1017/S1368980011002059

Measures of the home environment related to childhood obesity: a systematic review

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Submitted 22 November 2010: Accepted 8 July 2011: First published online 7 September 2011

Abstract

Objective: Due to a proliferation of measures for different components of the home environment related to childhood obesity, the purpose of the present systematic review was to examine these tools and the degree to which they can validly and reliably assess the home environment.

Design: Relevant manuscripts published between 1998 and 2010 were obtained through electronic database searches and manual searches of reference lists. Manuscripts were included if the researchers reported on a measure of the home environment related to child eating and physical activity (PA) and childhood obesity and reported on at least one psychometric property.

Results: Of the forty papers reviewed, 48% discussed some aspect of parenting specific to food. Fifty-per cent of the manuscripts measured food availability/accessibility, 18% measured PA availability/accessibility, 20% measured media availability/accessibility, 30% focused on feeding style, 23% focused on parenting related to PA and 20% focused on parenting related to screen time.

Conclusions: Many researchers chose to design new measures for their studies but often the items employed were brief and there was a lack of transparency in the psychometric properties. Many of the current measures of the home food and PA environment focus on one or two constructs; more comprehensive measures as well as short screeners guided by theoretical models are necessary to capture influences in the home on food and PA behaviours of children. Finally, the current measures of the home environment do not necessarily translate to specific sub-populations. Recommendations were made for future validation of measures in terms of appropriate psychometric testing.

Keywords
Child obesity
Home environment
Measurement
Psychometrics

The prevalence and severity of childhood overweight have increased significantly in the past three decades[1–3]. Negative sequalae from being overweight during childhood include being at a higher risk for a number of chronic and acute conditions[4] as well as negative social and psychological outcomes[5]. The source for the majority of childhood obesity cases can be attributed to energy imbalance which has been linked to changes in the food and physical activity (PA) environments[6,7].

The home environment has been documented as one that can either facilitate or inhibit healthful eating and PA, and caregivers play a key role in the development of the social and physical environment within a household[8,9]. From a social environment perspective, caregivers serve as role models for PA, dietary and media behaviours and influence the child's health behaviours and weight status through parenting strategies and feeding styles[10–21]. In addition, a child participates in more PA when a greater amount of space and active toys are available in the home[22,23]. Likewise, access to food items can impact consumption[24,25]. Similarly, when more screen opportunities are available, children are more likely to engage in sedentary behaviour[26,27].

Some researchers have conducted reviews of the home food environment[28,29], while others have described measures of the community food environment[30]. There have also been a number of literature reviews on interventions targeting families to improve PA, diet and weight status in children[31–36]. In each case there has been a consistent call for assessing relevant home environment variables with validated measures. To develop an accurate assessment of the influence of the home environment it is important to have strong conceptual models and appropriate validation methodology[37]. Several groups of

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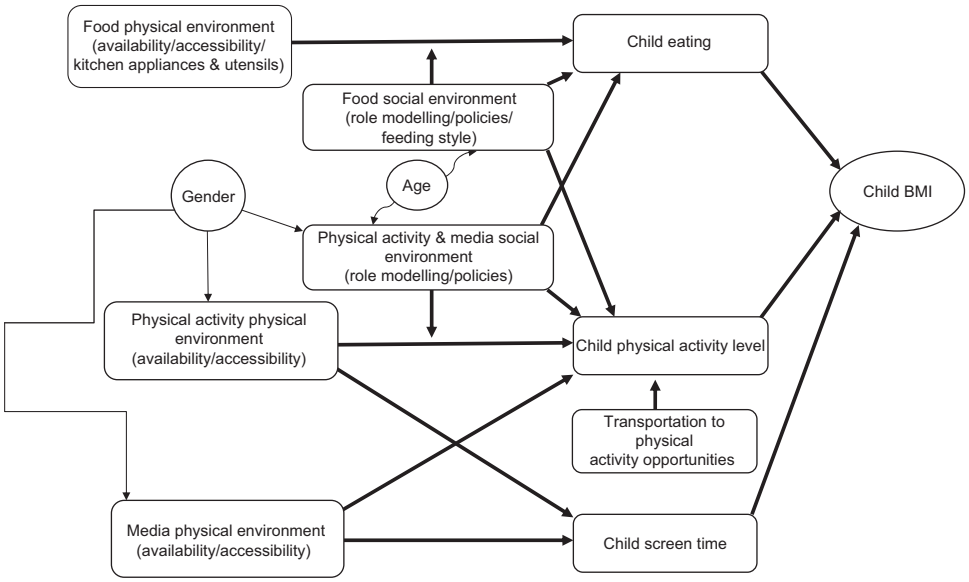

Fig. 1 Model of the home environment (modified from Gattshall *et al.*[38])

researchers have worked independently over the past few decades developing measures of caregiver influence on childhood obesity that are pertinent to specific programmes of research. As a result there is a wide variety of measures available that range in scope (i.e. constructs assessed). The disadvantage of having multiple measures of the home environment is the limited ability to compare results across studies. Owing to the proliferation of measures of different components of the home environment there is a need to provide clarity on which tools are available and the degree to which these can validly and reliably provide a comprehensive assessment of the home environment. Therefore, the purpose of the present systematic review is to examine the scope, reliability and validity of measurement tools of the home environment as it relates to childhood obesity.

Design

Evidence acquisition

Manuscripts published between 1990 and 2010 were searched for in the following databases: MEDLINE, PYSCLIT, CINAHL, ERIC and PsychINFO. The inclusive dates were selected since no review on measurement of the home environment has been conducted previously (only reviews of correlates and interventions) and we wanted to include the full spectrum of research in this area. Measurement work in this area conducted prior to 1990 is very limited, and measures from that time have generally been incorporated into existing literature. Citations of the articles resulting from the searches were also scanned for inclusion. Once relevant manuscripts validating measures were identified, further measurement articles were searched for using the title of the measure as a search term. Relevant studies were considered if the manuscript reported on a measure of the home environment related to children's diet, PA and weight status while also reporting at least one indicator of reliability or validity.

Measures were included if they were used in families with children between birth and 18 years of age, if they were completed by a child or an adult, and, for the latter, only if the adult measure was in reference to the home environment. The format could be paper-and-pencil, telephone/in-person interview, or completed by the researcher through direct observation.

Key terms utilized in the search included those defined by a Conceptual Model for Eating and Physical Activity Environment[38]: food physical environment, the food social environment, PA physical environment, PA social environment, media physical environment and media social environment, as well as terms related to psychometric properties. In each case (i.e. food, PA, media), the physical environment included availability and accessibility and the social environment included caregiver role modelling and policies (Fig. 1).

Exclusion criteria were: (i) unpublished literature reviews; (ii) manuscripts utilizing only a qualitative methodology; (iii) those not specific to children; and (iv) those in language other than English. Further, articles were also excluded if they (v) did not report on at least one of the following psychometric properties: test–retest reliability, inter-rater reliability, internal consistency, criteria validity, convergent validity, divergent validity, predictive validity or factorial validity. Two authors reviewed each manuscript and coded for home environment constructs and psychometric testing in order to meet criteria for inclusion.

https://doi.org/10.1017/S1368980011002059 Published online by Cambridge University Press

Results

Overall, the combined search strategies identified 2606 unique manuscripts. After reviewing the abstracts of these studies, 2463 were eliminated; another 109 were eliminated upon reading the full manuscript. The main reason for excluding articles was that the study did not report on any psychometric properties of the measure (see Table 1 for a summary of psychometrics). An additional six manuscripts were added from screening reference lists, yielding a total of forty manuscripts included in the present review. Of these forty manuscripts overlapping constructs assessed included: 48 % (*n* 19) some aspect of the food social environment[18,23,36,38,43,45,47,54–65]; 50 % (*n* 20) food physical environment[18,36,38–47,54,55,57,59,61–63,65]; 18 % (*n* 7) PA physical environment[23,38,48,49,51,52,63]; 20 % (*n* 8) media physical environment[23,27,38,49,51–53,63]; 30 % (*n* 12) food social environment[38,57,60,63,66,67–70,72–74]; 23 % (*n* 9)[23,38,48,52,54,56,60,63,64] parenting related to PA; and 20 % (*n* 8) PA and media social environment[23,27,38,52,53,60,63,64].

Psychometric properties across measures

Within each manuscript, internal consistency was the most commonly reported indicator of reliability (70 %) followed by test–retest reliability (38 %) and inter-rater reliability (8 %). Only 5 % reported on all three reliability indicators. Predictive and factorial validity were reported for 58 % and 25 % of the measures, respectively. However, convergent (8 %) and criteria (10 %) validity were rarely reported and no study provided all indicators of validity (Table 1).

Food availability and accessibility

Several researchers have developed measures of the availability and accessibility of healthy and less healthy foods in the home with most emphasis placed on fruits and vegetables[18,36,38–47,54,55,57,59,61–63,65]. While no gold standard exists for examining availability and accessibility of foods, some trials have used in-home inventories. This procedure involves a researcher checking food items that they observe as being present in the home[39,40]. Despite the validity of in-home inventories conducted by researchers, it is often not feasible to conduct this type of resource-intensive assessment and a checklist format completed by participants may be more practical. Many of the checklists focus on availability and accessibility of fruit and vegetables[11,40–45], and some on less healthful foods[18], while others include a full range of food groups to reflect the typical US diet[46]. Availability has also been assessed most basically by asking whether caregivers purchase foods on their child's request and if foods are visible[47]. When compared with consumption behaviours, the availability and accessibility of specific foods were related[11,18,40–45,47].

Fruit and vegetable availability and accessibility checklists have displayed moderate internal consistency even when availability and accessibility scales are collapsed (i.e. median $\alpha = 0{\cdot}69$)[40]. When compared with researcher observation, sensitivity and specificity were generally supported with higher false positive rates in the case of perishable items which tend to be consumed at a faster rate[41]. Additionally, some studies indicate that caregivers are more likely to report greater availability of fruits and vegetables than their children and that self-reported intake is more likely to correlate with the children's report[42,43]. Furthermore, the scales showed improved internal consistency when children reported ($\alpha = 0{\cdot}82$–$0{\cdot}92$)[42,45]. In the case of a more comprehensive checklist, agreement between the researcher and the participant (criterion validity) was substantial, supporting measure validity[46].

Physical activity availability and accessibility

Seven studies assessed PA availability and accessibility. Checklists are a commonly used method to assess these components of the home environment[23,38,48,49,51,52,63]. In one comprehensive and well-validated measurement of the PA environment Sirard *et al.*[49] asked participants to record whether they had specific equipment in categories and each item was multiplied by the score of accessibility. From this, researchers could rank the overall quality of the home environment score by a ratio of activity-to-media equipment[49]. The researchers recommended that this instrument be used in conjunction with other measurements (e.g. home food availability) to identify obesogenic home environments[49].

While these PA scales displayed moderate to high test–retest reliability (intra-class correlation coefficient (ICC) $= 0{\cdot}72$–$0{\cdot}99$)[48,49] one exception was for having a covered area outdoors and having active toys, where the internal consistency was low to moderate ($\alpha = 0{\cdot}43$–$0{\cdot}77$)[48]. Criterion validity, established by comparing the responses from the participant to those that were observed by the researcher, was generally high (Pearson $r = 0{\cdot}67$–$0{\cdot}98$)[49].

Media equipment availability

In a technology- and media-driven world, sedentary activities are often determined by the opportunities the child has to engage in screen behaviours[50]. Typically caregivers complete an inventory of items in their home that may encourage or support children's screen-based behaviours: television, digital video disc player, video games and others[27,51,52]. Similar to the assessment of fruit and vegetable availability, some researchers take a simple approach and inquire how many televisions are in the home and whether the child has a television in his/her bedroom[52,53]. With these measures, only the test–retest reliability was reported and the agreement between tests was high in each case (91–99 % agreement[27], ICC = 0·54–0.92[51], ICC = 0·79–0·90[52]).

https://doi.org/10.1017/S1368980011002059 Published online by Cambridge University Press

Table 1 Description of measures and psychometric properties

Authors	Construct assessed	Participants	Sample low-income	Culture/ethnicity	Inter-rater reliability	Test–retest reliability	Internal consistency	Criteria validity	Convergent validity	Predictive validity	Factorial validity	Content validity
FOOD PHYSICAL AND SOCIAL MEASURES												
Cullen *et al.*[57]	FV availability and accessibility, feeding style, parental role modelling and policies of healthy eating	4th–6th grade students (*n* 230)	No	25 % African American, 29 % European American, 37 % Mexican American, 9 % Asian	Not assessed	Pearson $r = 0{\cdot}30$–$0{\cdot}73$	$\alpha = 0{\cdot}19$–$0{\cdot}88$	Not assessed	Not assessed	Not assessed	Account for 11 % and 4 % variability	Not assessed
Campbell *et al.*[18]	Unhealthy food availability, policies for healthy eating (meal and eating formality, parenting consistency)	Parents of adolescents mean age 13·0 (SD 0·2) years (*n* 347)	No	Not reported (study conducted in Australia)	Not assessed	Not assessed	$\alpha = 0{\cdot}44$–$0{\cdot}82$	Not assessed	Not assessed	Regression models significantly predicted sweetened beverage consumption and sweet snack consumption accounting for 9–22 % of the variance	Not assessed	Not assessed
Vereecken *et al*[58]	Parental policies and role modelling regarding eating	Parents of pre-school children in Belgium, mean age 4·7 (SD 1·0) years (*n* 346)	No	Not reported (study conducted in Belgium)	Not assessed	Not assessed	$\alpha = 0{\cdot}71$–$0{\cdot}94$	Not assessed	Not assessed	Spearman correlations between intake and variables, $r = -0{\cdot}16$–$0{\cdot}59$	Not assessed	Not assessed
Campbell *et al.*[59]	Parental role modelling and policies for healthy eating, FV availability	Parent–child dyads, mean age of children 6·1 years (*n* 560)	Yes, range of SES	Not reported (study conducted in Australia)	Not assessed	Not assessed	$\alpha = 0{\cdot}64$–$0{\cdot}90$	Not assessed	Not assessed	Regression accounted for 2·8–11·7 % of the variance in outcome variables	Support for a 9-factor model	Not assessed
Young *et al.*[36]	FV availability, policies for healthy eating, parental modelling	Students aged 12–16 years (*n* 366)	33 % reported free or reduced-price lunch	82 % Caucasian, 6 % African American, 4 % multi-racial, 3 % Asian, 3 % Hispanic, 3 % American Indian	Not assessed	Not assessed	$\alpha = 0{\cdot}65$–$0{\cdot}85$	Not assessed	Not assessed	Regression supported variables predicting FV consumption accounting for 39 % of the variance	Not assessed	Not assessed
Neumark-Sztainer *et al.*[61]	Parental policies and role modelling of healthy eating, availability of FV	Children and adolescents at middle and high schools, mean age 14·9 (SD 1·7) years (*n* 3957)	School districts serving SES-diverse populations	48·5 % Caucasian, 9·0 % African American, 19·2 % Asian American, 5·8 % Hispanic, 3·5 % Native American, 3·9 % mixed/other	Not assessed	Not assessed	$\alpha = 0{\cdot}43$–$0{\cdot}81$	Not assessed	Not assessed	Pearson correlations with outcome variables, $r = -0{\cdot}09$–$0{\cdot}33$	Support for a 13-factor solution	Not assessed
Wilson *et al.*[65]	FV availability and accessibility, parental policies for health eating	Children aged 10–12 years (*n* 141)	No	No information	Not assessed	ICC = 0·47–0·66	$\alpha = 0{\cdot}50$–$0{\cdot}80$	Not assessed	Not assessed	Pearson $r = 0{\cdot}36$–$0{\cdot}48$	Not assessed	Not assessed
Rosno *et al.*[39]	Food (all types) availability	Parents of overweight children aged 6–18 years, mean age 11·6 (SD 2·5) years (*n* 63)	No	83 %, European American, 6 % African American, 4 % Native American, 8 % 'other'	95 % agreement between researchers	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Hearn *et al.*[40]	FJV availability and accessibility	Parents of elementary-school children	No	Not reported (study conducted in Australia)	Not assessed	Not assessed	$\alpha = 0{\cdot}69$	Not assessed	Not assessed	Pearson correlation to intake, $r = 0{\cdot}11$–$0{\cdot}54$	Not assessed	Not assessed
Marsh *et al.*[41]	FV availability	Parents of 4th–6th grade children interviewed; mean age of parents 42·1 years (*n* 48)	No	48 % white, 33 % Mexican American, 8 % black, 11 % Asian/other	Not assessed	Not assessed	Not assessed	Sensitivity and specificity = 34·5–42·0 % (75·9 % agreement; false positive = 19·4–20·6 %; false negative = 3·6–4·1 %)	Not assessed	Not assessed	Not assessed	Not assessed
Cullen *et al.*[42]	FV availability and accessibility	4th–6th grade children (*n* 225) and their parents (*n* 88); mean age of parents 40 (SD 6·6) years	No	Children with non-participating parents (26 % African American, 31 % European American, 31 % Hispanic, 12 % Asian); children with participating parents (22 % African American, 32 % European American, 33 % Hispanic, 13 % Asian)	Not assessed	Not assessed	$\alpha = 0{\cdot}30$–$0{\cdot}85$	Not assessed	Not assessed	For children with high FJV preferences, FJV availability predicted consumption; both availability and accessibility were significantly related to consumption for children with low FJV preferences	Not assessed	Not assessed

Table 1 *Continued*

Authors	Construct assessed	Participants	Sample low-income	Culture/ethnicity	Inter-rater reliability	Test–retest reliability	Internal consistency	Criteria validity	Convergent validity	Predictive validity	Factorial validity	Content validity
De Bourdeaudhuij *et al.*[43]	Parental role modelling and policies for nutrition, food availability	Children aged 10–11 years (*n* 326)	No	76 % in Norway, 99 % in Spain, 100 % in Portugal, 82 % in Denmark and 99 % in Belgium	Not assessed	ICC = 0·42–0·88	$\alpha = 0{\cdot}13$–$0{\cdot}93$	Not assessed	Not assessed	Significant Spearman correlations in appropriate directions, $r = -0{\cdot}20$–$0{\cdot}54$	Not assessed	Not assessed
Cullen and Thompson[44]	FV availability	Parents of children aged 9–12 years (*n* 67)		Mostly African American	Not assessed	Not assessed	$\alpha = 0{\cdot}82$–$0{\cdot}92$	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Cullen *et al.*[45]	FJV availability and accessibility, parental policies for healthy eating	Parents of 6th grade children, interviewed (*n* 109)	No	61 % African American, 67 % Hispanic American, 54 % Euro-American	Not assessed	Pearson $r = 0{\cdot}39$–$0{\cdot}92$	$\alpha = 0{\cdot}06$–$0{\cdot}84$	Not assessed	Not assessed	Not assessed	9–55 % of variability	Not assessed
Fulkerson *et al.*[46]	Food availability	Sample 1 (criterion validity): *n* 51 adults; sample 2 (construct validity), parents of a child 10–17 years (*n* 349)	No	Sample 1: 68 % white, 14 % black, 6 % American Indian, 2 % Asian, 4 % Hispanic; sample 2: 99 % white	Not assessed	Not assessed	Not assessed	Sensitivity and specificity for food groups in range 0·70–0·95	Not assessed	Significant correlations with consumption of food groups, Pearson $r = 0{\cdot}13$–$0{\cdot}37$	Not assessed	Not assessed
Dave *et al.*[62]	Parental role modelling and policies related to nutrient, FV availability and accessibility	Parents of children in 1st–5th grade (*n* 184)	Yes	Mostly Hispanic	Not assessed	Not assessed	$\alpha = 0{\cdot}69$–$0{\cdot}87$	Not assessed	Not assessed	Not assessed	Support for a 6-factor solution	Not assessed
Evans *et al.*[55]	FV availability and accessibility, parental policies for healthy eating	Parents of children in 4th–5th grade (*n* 31)	27 % low SES	50 % African American	Not assessed	Not assessed	$\alpha = 0{\cdot}67$–$0{\cdot}94$	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
van Assema *et al.*[47]	Parental policies for healthy eating, FV availability and accessibility, sweets and fats availability and accessibility	Parent–child dyads with children aged 12–14 years, mean child age 12·7 years, mean parent age 41·9 years (*n* 502)	No	Not reported (participants were Dutch)	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Significant $\beta = -0{\cdot}24$–$0{\cdot}32$	Not assessed	Not assessed
FOOD SOCIAL ENVIRONMENT – FEEDING STYLE												
Birch *et al.*[66]	Feeding style	Sample 1: parents of 5–9-year-old girls (*n* 394); sample 2: parents of 8–11-year-old children (*n* 148); sample 3: parents of 7–11-year-old children (*n* 126)	Sample 1: 29 % < $US 35 000 pa	Sample 2: 85 % non-Hispanic white, 9 % African American, 4 % Hispanic; sample 3: 90 % Hispanic, 6 % non-Hispanic white	Not assessed	Not assessed	$\alpha = 0{\cdot}70$–$0{\cdot}92$	Not assessed	Not assessed	Not assessed	Support for a 7-factor model	Not assessed
Robinson *et al.*[67]	Feeding style	Parents of children (mostly mothers), mean age of child 8·4 (SD 0·4) years ($n = 957$)	Yes	44·8 % white, 20·7 % Asian, 3·8 % African American, 19·3 % Hispanic, 9·7 % multi-ethnic, 0·7 % Native American, 1·3 % Pacific Islander	Not assessed	Not assessed	$\alpha = 0{\cdot}61$–$0{\cdot}64$	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Kroller and Warschburger[74]	Feeding style	Mothers of 3–6-year-olds (*n* 219)	33·5 % below poverty level	94·5 % German nationality	Not assessed	Pearson $r = 0{\cdot}41$–$0{\cdot}78$	$\alpha = 0{\cdot}73$–$0{\cdot}93$	Not assessed	Not assessed	Feeding strategies accounted for 22·2 % of eating habits	Not assessed	Not assessed
Wardle *et al.*[69]	Feeding style	Families with same-sex twins, mean age 4 years (*n* 214)	No	No information	Not assessed	Pearson correlation $r = 0{\cdot}76$–$0{\cdot}83$	$\alpha = 0{\cdot}69$–$0{\cdot}92$	Not assessed	Not assessed	Compared subscale results to weight status of the family, not related diet behaviours	Not assessed	Not assessed
Joyce and Zimmer-Gembeck[72]	Feeding style	Caregivers to children aged 4–8 years, mean age 5.7 (SD 0·9) years (*n* 247)	No	94 % white (study conducted in Australia)	Not assessed	Not assessed	$\alpha = 0{\cdot}60$–$0{\cdot}83$	Not assessed	Not assessed	Predicted BMI *Z*-score with PFDQ subscales, related health behaviours not tested	Not assessed	Not assessed

Table 1 *Continued*

Authors	Construct assessed	Participants	Sample low-income	Culture/ethnicity	Inter-rater reliability	Test–retest reliability	Internal consistency	Criteria validity	Convergent validity	Predictive validity	Factorial validity	Content validity
Arredondo *et al.*[73]	Feeding style	Latino mothers of children K-grade 2 (*n* 387)	40 % made < $US 1500/month	Latino	Not assessed	Not assessed	$\alpha = 0{\cdot}72$–$0{\cdot}87$	Not assessed	Not assessed	Monitoring, reinforcement and discipline correlated with healthy eating and unhealthy eating ($r = -0{\cdot}17$–$0{\cdot}45$)	Not assessed	Not assessed
Ogden *et al.*[68]	Feeding style (overt and covert control over child's eating)	Study 1: parents of children aged 4–11 years (*n* 297); study 2: parents of children (*n* 61)	No	Study 1: 80 % white	Not assessed	Not assessed	$\alpha = 0{\cdot}63$–$0{\cdot}83$	Not assessed	Significant correlation with CFQ subscales, Pearson $r = 0{\cdot}26$–$0{\cdot}53$	Not assessed	Support for overt and covert control factors (accounting for 22–28 % variance)	Not assessed
Hughes *et al.*[70]	Feeding style	Parents of children aged 3–5 years (*n* 231)	Yes	43 % African American, 56 % Hispanic	Not assessed	Pearson $r = 0{\cdot}82$–$0{\cdot}85$	$\alpha = 0{\cdot}58$–$0{\cdot}86$	Not assessed	CFQ, $F(9,518) = 3.17$, $P < 0.001$; Parenting Dimensions Inventory, $F(27,602) = 2{\cdot}26$, $P < 0{\cdot}001$	Not assessed	Support for a 2-factor model supported	Not assessed
PHYSICAL ACTIVITY AND/OR MEDIA PHYSICAL AND SOCIAL MEASURES												
Hume *et al*[48]	Parental role modelling and policies for PA, PA availability	Grade 5 and 6 children, mean age 11·1 (SD 0·7) years (*n* 39)	No	Not reported (study conducted in Australia)	Not assessed	ICC = 0·72–0·88	$\alpha = 0{\cdot}43$–$0{\cdot}77$	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Sirard *et al.*[49]	PA availability and accessibility (& media)	Parent–child dyads with children aged 10–18 years (*n* 31)	No	52 % white, 19 % African American, 6 % Mexican American, 6 % Native American, 6 % Asian	Not assessed	ICC = 0·87–0·99; $\kappa = 0.42$–$1{\cdot}00$	Not assessed	Pearson $r = 0{\cdot}67$–$0{\cdot}98$	Not assessed	Not assessed	Not assessed	Not assessed
Rosenberg *et al.*[51]	PA and media equipment availability	Adolescents (*n* 189; mean age 14·6 years), parents of adolescents (*n* 171; mean age 45·0 years), and parents of younger children (*n* 116; parents' mean age 39·6 years; children's mean age 8·3 years)	No	62 % white (participants from 3 US cities)	Not assessed	Between parent and child agreement, ICC = 0·49–0·93	Not assessed	Not assessed	Not assessed	Availability of equipment predicted media behaviour, $\Delta R^2 = 0{\cdot}00$–$0{\cdot}15$	Not assessed	Not assessed
Timperio *et al.*[52]	PA and media availability and role modelling	Boys and girls aged 10–12 years (*n* 344)	Yes	Not reported (study conducted in Australia)	Not assessed	ICC = 0·79–0·90	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
van Zutphen *et al.*[53]	Policies regarding TV, TV availability	Parents of children aged 4–12 years (*n* 1926)	Yes	Not reported (study conducted in Australia)	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Mann–Whitney, Kruskal–Wallis and ANOVA supported differences in TV viewing based on variables measures ($P < 0{\cdot}05$)	Not assessed	Not assessed
Salmon *et al.*[27]	Availability of media equipment, parental role modelling and policies regarding screen time	Parents of children 10–12 years old, mean age 11·5 (SD 0·6) years (*n* 927)	30 % low SES	Not reported (study conducted in Australia)	Not assessed	ICC = 0·60–0·83	$\alpha = 0{\cdot}61$	Not assessed	Not assessed	Significant *t* tests between subscales and TV viewing and PA levels	Not assessed	Not assessed
COMBINED FOOD AND PHYSICAL ACTIVITY MEASURES												
Golan and Weizman[54]	Role modelling of eating behaviours and PA, availability of unhealthy foods (stimulus)	Mothers of children aged 6–11 years (*n* 60)	No	Not reported (study conducted in Israel)	Pearson $r = 0{\cdot}81$–$0{\cdot}94$	Pearson $r = 0{\cdot}78$–$0{\cdot}90$	$\alpha = 0{\cdot}78$–$0{\cdot}88$	Not assessed	Not assessed	Correlation between child's weight loss and change in FEAHQ score, Pearson $r = 0{\cdot}36$–$0{\cdot}73$	Not assessed	Expert panel supported items

Table 1 *Continued*

Authors	Construct assessed	Participants	Sample low-income	Culture/ethnicity	Inter-rater reliability	Test–retest reliability	Internal consistency	Criteria validity	Convergent validity	Predictive validity	Factorial validity	Content validity
Gattshall *et al.*[38]	All dimensions	Parents (mean age 40 years) of children aged 8–12 years (mean age 10·5 years)	No	61·3 % white, 6·1 % black, 3·3 % Asian, 3·8 % American Indian, 23·6 % Latino	Pearson r = −0·08–1·00	Pearson r = 0·43–0·99	α = 0·59–0·84	Not assessed	Not assessed	Pearson correlations with outcome variables, r = 0·14–0·36	Not assessed	Not assessed
Larios *et al.*[60]	Policies for diet, PA and media, feeding style	Phase 2: mothers of children kindergarten – 2nd grade (n 91); phase 3: mothers of children in elementary school (n 714)	37 % made < $US 1500/ month	Latina mothers	Not assessed	Not assessed	α = 0·81–0·83	Not assessed	Significant correlations with corresponding CFQ subscale	Significant correlations with behavioural strategies related to PEAS subscales	Five-factor structure supported with 7–24·5 % of variance accounted for	Not assessed
Spurrier *et al.*[23]	PA and media availability, role modelling of PA, parental policy regarding PA, media and diet	Parents of pre-school children (n 280)		Not reported (study conducted in Australia)	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Significant ANOVA between inventory subscales and screen time, PA and diet behaviours	Not assessed	Not assessed
Bryant *et al.*[63]	ALL dimensions	Parents of children aged 3–8 years (n 85)	10·5 % < $US 1900/month	72·9 % white and 23·5 % black	Not assessed	% agreement = 84·4–95·6	Not assessed	% agreement = 80·5–96·3	Not assessed	Not assessed	Not assessed	Not assessed
Pearson *et al.*[56]	Parental role modelling and policies for PA and eating	Parent–child dyads of children aged 10–12 years (n 775)	Respondents selected from post codes from high, mid, low income levels	Not reported (study conducted in Australia)	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Pearson χ^2 test revealed differences in diet and PA behaviours based on variables measured (OR = 0·4–2·6)	Not assessed	Not assessed
Ihmels *et al.*[64]	Policies for TV, parental role modelling for TV, diet and PA	Parents of 1st grade children (n 438)	34 % < $US 20 000 pa	68·0 % Caucasian, 11·6 % African American, 11·5 % Hispanic, 4·8 % Asian (4·1 % 'other')	Not assessed	Not assessed	α = 0·72	Not assessed	Not assessed	Significant Pearson correlations with outcome variables, r = −0·2–0·66	Support for a 5-factor solution accounting for 5–17 % of variance	Not assessed
Total (n 40)	40 (100 %)	40 (100 %)	16 (40 %)	25 (63 %)	3 (8 %)	15 (38 %)	28 (70 %)	4 (10 %)	3 (8 %)	23 (58 %)	10 (25 %)	1 (3 %)

FV, fruit and vegetable; availability and accessibility = physical environments; parental policies/rules, role modelling = social environments; FJV, fruit, juice and vegetable; PA, physical activity; TV, television; SES, socio-economic status; ICC, intra-class correlation coefficient; CFQ, Child Feeding Questionnaire; PFDQ, Parent Feeding Dimensions Questionnaire; FEAHQ, Family Eating and Activity Habits Questionnaire; PEAS, Parenting Strategies for Eating and Activity Scale.

Role modelling and policies

Beyond the physical environment in the home, caregivers are also responsible for establishing the social environment that influences health behaviours[8,38,54]. Some researchers focus on social support for healthy eating and PA[36,55], while others use different terminology for a similar construct, such as asking children how often they were active with family members and if somebody at home encouraged them to be active[54]. Another method to consider how caregivers can socially influence health behaviours in their children is to examine rules and policies that they implement, including meal formality and consistency[18,27,47] as well as role modelling of healthy eating and PA[51,56–59].

Overall, caregiver role modelling, support and rules and policies were all significant predictors of dietary intake and PA behaviours[18,27,36,47,48,51,56–58]. Specifically, rules, policies and social support regarding media supported less screen time in children. Caregiver role modelling is a consistent correlate of positive health behaviours in children and not necessarily within the same behaviour domain (i.e. diet or PA). Internal consistencies ranged from moderate to high ($\alpha = 0{\cdot}64$–$0{\cdot}94$)[18,27,36,48,57,58] and test–retest reliability was high (ICC = 0·61–0·90)[27,48].

A good example of a measure developed and validated with a focus on caregiver role modelling and policies is the Parenting Strategies for Eating and Activity Scale (PEAS)[60]. The PEAS was tested in a sample of Latino women to evaluate a wider range of parenting strategies and demonstrated moderate to high internal consistency ($\alpha = 0{\cdot}81$–$0{\cdot}82$)[60]. Construct validity was established for the PEAS by correlating the subscales with the appropriate subscales of a child feeding questionnaire.

Multiple components of the home environment

In attempts to assess multiple components of the home environment (e.g. those outlined in the Conceptual Model for Eating and Physical Activity Environment), several researchers have developed measurement tools with multiple subscales. These measurement tools contain a range of constructs and psychometric qualities which make them appropriate for use in different instances.

For comprehensive assessments of both environmental and behavioural components, Neumark-Sztainer *et al.*[61] developed a 221-item questionnaire assessing a range of socio-environmental, personal and behavioural factors associated with dietary intake among adolescents[61]. Items identified to be relevant for the current review were availability of vegetables and family meal patterns as a source of caregiver role modelling, which demonstrated moderate internal consistency ($\alpha = 0{\cdot}63$–$0{\cdot}78$)[61] and test–retest reliability ($r = 0{\cdot}66$–$0{\cdot}69$)[17].

An example of a tool to assess multiple attitudinal and caregiver practices is the Home Nutrition Questionnaire developed by Dave *et al.*[62]. Six factors were identified in a low-income and mainly Hispanic population: child's preferences for fruit and vegetables, caregiver practices that promote fruit and vegetables, caregiver role modelling, perceived cost of fruit and vegetables, perceived benefits of fast food and eating while watching television. The internal consistency of the scales was moderate to high ($\alpha = 0{\cdot}69$–$0{\cdot}87$)[62].

Bryant *et al.*[63] assessed multiple components of the home environment in their Healthy Home Survey (HHS) including food, media and PA availability and accessibility, caregiver role modelling and policies for eating and PA. The test–retest was high for most items except fresh fruit. Validity (in-home assessments) estimates were lowest for sweet snacks ($\kappa = 0{\cdot}00$) and fresh vegetables ($\kappa = 0{\cdot}23$) and highest for frozen fruit ($\kappa = 0{\cdot}87$) and dried fruit ($\kappa = 0{\cdot}85$). Food accessibility showed good reliability (biased-adjusted kappa (PABAK) = 0·96) and poor validity (PABAK = 0·85). The results of the HHS suggest that measurement of variety and quantity of foods may be a better indicator than presence or absence alone.

Finally, Gattshall *et al.*[38] developed and tested the Home Environment Survey (HES) which assesses a breadth of home environment variables including the availability and accessibility of food and PA, caregiver role modelling and policies for healthy eating and PA. The internal consistencies were moderate to high for these scales ($\alpha = 0{\cdot}66$–$0{\cdot}84$), except for the accessibility of fat and sweets scale ($\alpha = 0{\cdot}59$) and accessibility for fruits and vegetables was reduced to a single item due to poor reliability. As the researchers suggest, perhaps the internal consistency was lower on these subscales because they were too broad (i.e. 'How often do you store high-calorie foods in a place that was known but not seen?'). Another theory could be that that the items were too embedded (they ended up being confusing for the participant because they had too much information 'embedded', so that the participant could not cognitively interpret the construct). Test–retest and inter-rater reliabilities were low to high ($r = 0{\cdot}49$–$0{\cdot}99$ and $r = 0{\cdot}22$–$0{\cdot}70$, respectively), indicating some differences between caregiver report of the home environment. The subscales showed strong predictive validity for both the child and caregiver.

Screeners or short measures

Short screeners are useful as a brief and easy-to-administer tool to assess the overall home environment 'at a glance', giving the researcher a gross estimate of the family's home environment. Only three screeners are described in the literature which assess the overall impact of the home environment related to childhood obesity. Ihmels *et al.*[64] developed and tested the Family Nutrition and Physical Activity (FNPA) screening tool for familial environment and behaviours that may predispose a child to become overweight. This is a twenty-one-item screening tool was developed based on established Evidence Analyses procedures of the American Dietetic Association, which demonstrates high content validity. The FNPA assesses

caregiver role modelling of nutrition and PA, television availability and dietary/nutrition/sleep behaviours. Similarly, Wilson *et al.*[65] developed and tested the Child Nutrition Questionnaire which assesses fruit and vegetable availability and accessibility and policies for healthy eating in fourteen items. They found moderate test–retest reliability in ten of the twelve scales and low to moderate internal consistencies ($\alpha = 0{\cdot}50$–$0{\cdot}80$). Golan and Weizman[54] created the Family Eating and Activity Habits Questionnaire (FEAHQ) and included the availability of unhealthy foods as an indicator of stimulus exposure in addition to child eating behaviours. The eight items assessing availability had moderate internal consistency ($\alpha = 0{\cdot}78$) and the test–retest was acceptable.

Feeding style

Feeding style has received much attention in research, largely separate from the home environment, but is relevant to the social food environment as it is closely related to policies for healthy eating. Birch *et al.*[66] established the Child Feeding Questionnaire (CFQ), a seven-factor model which focused on two broad categories: (i) parental perceptions and (ii) concerns for and use of child feeding practices. Seven factors included: perceived responsibility for the child's weight, perceived parent weight, perceived child weight, concern about child weight, pressure to eat, restriction and monitoring, and all subscales had high internal consistency ($\alpha \geq 0{\cdot}71$)[66].

Many researchers have modified or simply used certain subscales of the original CFQ based upon their research questions. In the interest of having a child's perspective on feeding style, the CFQ has been adapted from a parent-reported tool to a child-reported one[18]. With an emphasis on controlling feeding styles in a low-income population, it was concluded that previous findings of control being related to greater body weight of the child may not apply to younger children (aged 8–9 years) of diverse ethnic and sociodemographic backgrounds[67]. The internal consistency of the control scale was low ($\alpha = 0{\cdot}61$)[67]. Similarly, Ogden *et al.*[68] wanted to expand the concept of child feeding to differentiate between overt and covert control, with overt control defined as controlling a child's food intake in a way that the child can detect while covert control cannot be detected by the child[68]. The two control scales had adequate internal consistency ($\alpha = 0{\cdot}78$–$0{\cdot}83$)[68].

Beyond controlling feeding styles, some researchers have developed items to reflect slightly different constructs from the CFQ: emotional feeding, instrumental feeding, prompting or encouraging child to eat, and control over eating[69]. These four subscales demonstrated moderate internal consistency ($\alpha = 0{\cdot}65$–$0{\cdot}85$) and test–retest reliability ($r = 0{\cdot}67$–$0{\cdot}83$)[69]. Hughes *et al.*[70] wanted to expand the concept of child feeding to include dimensions of Maccoby and Martin's[71] typology of general parenting (demandingness and responsiveness) regarding the child's eating: parent-centred and child-centred strategies[70]. These two scales revealed high test–retest reliability ($r = 0{\cdot}82$–$0{\cdot}85$) and convergent validity was supported by the subscales being correlated with the appropriate subscales on the CFQ[70]. Similarly, Joyce and Zimmer-Gembeck[72] assessed multiple parental feeding-specific dimensions including: supportiveness, structure, coerciveness and chaos ($\alpha = 0{\cdot}72$–$0{\cdot}92$).

Arredondo *et al.*[73] adapted the CFQ based upon focus groups with Latina mothers and yielded a five-factor measure: monitoring, discipline, control, limit setting and reinforcement ($\alpha = 0{\cdot}72$–$0{\cdot}87$). Kroller and Warschburger[74] tested parental feeding strategies through translated items from two measures assessing restriction, monitoring, pressure, rewarding, child's control and modelling. These scales demonstrated adequate internal consistency ($\alpha = 0{\cdot}75$–$0{\cdot}93$) and moderate test–retest reliability (Pearson $r = 0{\cdot}41$–$0{\cdot}78$)[74].

Discussion

Several reviews of childhood obesity interventions focusing on the home or caregiver involvement have been conducted[31,34]. These reviews conclude that behavioural interventions including the family are effective; however, the mechanism of change is unclear[75]. In order for research in the area of the home environment and childhood obesity to move forward a greater emphasis on appropriate measurement is necessary. The current review assessed measures of the home environment in a broad sweep of the literature in order to gain a better understanding of appropriate measures of these complex constructs using a conceptual model as a guiding framework[38]. The literature review resulted in forty manuscripts describing measurement of different aspects of the home environment. The sample would have been much larger had we included manuscripts describing measurements that did not have any supporting reliability and validity; however, it was the purpose of the review to describe those measures which have some psychometric evaluation. The reader is directed to Table 1 as a resource tool to identify and evaluate the measurement tools available assessing different components of the home environment. Table 1 describes the measurement tools, identifies which constructs are assessed, which population the tool was validated with, whether this sample included specific sub-populations (i.e. low-income, racial/ethnic minorities) and the results of any psychometric testing.

The objective of the current review was to assess the degree to which measurement tools of the home environment can validly and reliably provide assessment. The overall finding was that although many of the reviewed measurement tools have supporting psychometric properties, there is no consistency across similar types of measures (i.e. checklists *v.* subscales *v.* screeners) as to which psychometric properties are appropriate as supporting evidence. For example, Bollen and Lennox

warn that not all types of scales lend themselves to item covariance (i.e. internal consistency)[76]. Further, causal indicators of the latent construct do not necessarily need to be related to each other to provide meaningful assessment of the latent construct[76]. Table 2 was developed as part of the review to help guide researchers in the validation of measurement tools utilizing specific types of psychometric properties for certain types of scales for assessing the home environment (checklists, subscales or screeners). One method of validation that is often overlooked is assessing other variables that are effects, or outcomes, of the latent construct[76]. This method should be employed more often when building measurement and theoretical models in concert with survey development and validation.

In conducting the present review, it was evident that many researchers chose to design new measures for their studies and often the tools employed were brief with a lack of reporting of psychometric properties. This is also evident in the number of measures that researchers have employed that were not included in the current review as they did not report any psychometric properties. When considering the psychometric findings, the data support the conclusion that the measures have adequate reliability, but that evidence of validity is more equivocal. It is important to note that although a measure is reliable, that does not support the validity. Based upon the results of the current review, there is a need for more measurement studies assessing the validity of measurement tools.

While additional validity studies are needed, it is also critical to test existing measures in diverse samples as current measures of the home environment may not necessarily translate to specific sub-populations. The majority of existing efforts to validate home environment measures did not seek out specific populations that experience obesity at disproportionate rates, such as low-income and/or ethnic/minority families. Future measurement efforts may want to focus on assessing the home environment of these harder-to-reach families in order to garner a better understanding of the factors that influence these important health behaviours, especially as many obesity prevention interventions currently target at-risk populations.

Despite limitations across studies, several researchers have designed and tested aspects of the home environment. For example, Bryant *et al.*[29] and Gattshall *et al.*[38] have both put forth two comprehensive measures of the home environment assessing both social and physical environments that influence childhood obesity. Conversely many research studies call for brevity in measurement, and screening tools that asses key components of the home environment that place children at risk for becoming obese have utility. Currently there are only three screening tools are evident in the literature. Further research that expands these measures is warranted.

Although closely related to policies and role modelling of healthy eating and PA, child feeding is a unique construct which has been studied extensively. The CFQ

Table 2 Recommendations for psychometric properties with scale type

	Validity					Reliability		
	Criteria	Convergent	Predictive	Factorial	Content	Test–retest	Inter-rater	Internal consistency
Method	Conduct a verification of the participant report with an in-home assessment; compare sensitivity and specificity	Administer a previously validated tool (ideally a 'gold standard') of the same construct and assess the correlation	Assess the relationship of the construct of interest with variables that should theoretically be related	Conduct factor analyses early on in the validation process to establish the observed variables (subscales) that are components of the latent variable	During the development of the tool have experts review the items to ensure all facets of the construct are included and/or conduct cognitive interviews with members of the target audience	Administer the tool to participants twice, approximately two weeks apart	Administer the tool to dual raters concurrently	Calculate a measure of 'relatedness' for items within one subscale (i.e. Cronbach's α, ICC, κ)
Type of scale								
Checklist – availability	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Subscales	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Screening tool	No	Yes	Yes	No	Yes	Yes	Yes	No

ICC, intra-class correlation coefficient.

https://doi.org/10.1017/S1368980011002059 Published online by Cambridge University Press

has been employed, manipulated and tested by a number of researchers, as have the factors involving caregiver perceptions and concerns regarding child feeding practices[65]. Researchers should consider child feeding in their assessment of the social home environment related to nutrition. In addition to social aspects of the home environment, reporting of physical components by adults *v.* children has yielded interesting results. A few studies showed that when children reported availability of food items in the home, the internal consistency improved. One explanation is that caregivers may be more biased because they are motivated to appear as good providers of more healthful food options for their children. However, this requires further investigation along with validation studies.

The conceptual model guiding the present review[38] did not include the influence of siblings on behaviours within the home. Future research on the home environment may choose to include sibling variables and acknowledge the complexity of familial influences. However, a strength of the review is that it was guided by a theoretical model that was expanded (e.g. feeding style incorporated), resulting in a comprehensive review of measures of the home environment related to childhood obesity. Multiple measures assessing similar constructs of the home environment currently hinder a comparative analysis across studies. Many of the current measures of the home food and PA environment focus on one or two constructs; more comprehensive measures are necessary to capture influences in the home on food and PA behaviours of children. This calls for a more concerted effort to gain a better understanding of familial influences on childhood obesity. Once consistency in the measurement of the family and home environment has been established, the quality of the validation studies should be assessed.

Conclusions

The current review provides a summary and evaluation of measurement tools available in the assessment of the home environment related to childhood obesity. Practitioners can reference the available tools for use in assessing programmatic outcomes while researchers can review the available tools and use the guidance provided for future validation studies. The results of the current review clearly identify a need for comprehensive tools, assessment of specific constructs and short screeners. If more deliberate action is taken to improve and validate existing tools and create new ones with greater emphasis on appropriate measurement models and forms of psychometric testing, the evidence base behind childhood obesity interventions and epidemiological studies focusing on the home environment will be advanced.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The authors declare no conflicts of interests. All authors contributed to the development and production of the literature review. C.A.P. conducted the literature review under the guidance of P.A.E., M.M.M., M.H.H. and E.L.S.; P.A.E., M.M.M., M.H.H. and E.A.S. also edited the manuscript. A.L.Y. provided direction in terms of synthesizing the literature and edits overall.

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