



## ORIGINAL RESEARCH

# The acceptability and feasibility of using a 3D body size scale to initiate conversations about weight in toddlerhood: a mixed-methods study

Kristiane Tommerup<sup>1</sup>  | Andrea D. Smith<sup>1</sup>  | Elizabeth H. Evans<sup>2</sup>  |  
Helen Croker<sup>3</sup>  | Andrew Steptoe<sup>1</sup>  | Martin J. Tovee<sup>4</sup>  | Alison Fildes<sup>5</sup>  |  
Clare Llewellyn<sup>1</sup> 

<sup>1</sup>Obesity Research Group, Department of Behavioural Science and Health, University College London (UCL), London, UK

<sup>2</sup>School of Psychology, Newcastle University, Newcastle upon Tyne, UK

<sup>3</sup>Great Ormond Street Institute of Child Health, Faculty of Population Health Sciences, University College London (UCL), London, UK

<sup>4</sup>Department of Psychology, Northumbria University, Newcastle upon Tyne, UK

<sup>5</sup>School of Psychology, University of Leeds, Leeds, UK

## Correspondence

Kristiane Tommerup, Department of Behavioural Science and Health, 1-19 Torrington Place, University College London, Gower Street, London, England.  
Email: kristiane.tommerup.14@ucl.ac.uk

## Funding information

National Institute for Health Research, Grant/Award Number: PR-PRU-0916-21001

## Summary

**Background:** Health Care Professionals struggle to initiate conversations about overweight in toddlerhood. A novel 3D body size scale (3D BSS) may facilitate engagement with this topic during pediatric appointments.

**Objectives:** To explore barriers and facilitators to using the 3D BSS through a mixed-methods design.

**Methods:** For the qualitative phase, parents of toddlers (n = 38) participated in semi-structured interviews introducing the 3D BSS of 4–5-year-old children. For the quantitative phase, pre- and post-interview questionnaires were administered to ascertain the acceptability of the 3D BSS.

**Results:** Parents rated the 3D BSS as “very” (n = 20, 52.6%) to “moderately” (n = 12, 31.6%) acceptable. Thematic analysis revealed four barriers to acceptability: i) the sensitive nature of child weight, ii) the belief that weight does not determine health, iii) the visual normalisation of overweight and iv) the need to account for individual variation in growth patterns. However, these barriers could be overcome through three facilitators: i) the provision of expert guidance ii) the value of simple tools, and iii) tailoring conversations to familial needs.

**Conclusions:** Parents considered the 3D BSS an acceptable visual resource to discuss child weight during routine appointments. However, the acceptability of the tool was conditional on a sensitive, collaborative, and tailored delivery approach.

## KEYWORDS

child growth, health care professionals, mixed-methods, pediatric obesity, pre-schoolers, visual tools, weight conversations

## 1 | INTRODUCTION

The increasing prevalence of childhood obesity is a public health priority.<sup>1</sup> Excess adiposity tracks from toddlerhood into adolescence.<sup>2</sup> In

**Abbreviations:** 3D BSS, 3D Body Size Scale; BMI, Body Mass Index; HCPS, Health Care Professionals; HTS, Healthy Toddler Study.

Kristiane Tommerup, Andrea D. Smith, Alison Fildes and Clare Llewellyn contributed equally.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2020 The Authors. *Pediatric Obesity* published by John Wiley & Sons Ltd on behalf of World Obesity Federation.

retrospective analyses of children in Germany, nearly 90% of 3-year-old children with a body mass index (BMI) in the obese range (BMI > 99th percentile) continued to be affected by overweight or obesity into late adolescence ( $n = 51\,505$ ).<sup>2</sup> Moreover, adolescents with obesity showed the greatest acceleration in their BMI between the ages of 2 and 6, highlighting this period as critical for children's weight development. In order to address the development and sustainment of excess adiposity in childhood, obesity prevention efforts need to start early.<sup>3</sup>

Overweight in early childhood can be difficult to identify by sight alone. Both caregivers and Health Care Professionals (HCPs) often do not recognise overweight in young children.<sup>4</sup> In a review of 51 experimental studies, 86% of parents with 2 to 6-year-old children did not recognise overweight in their child.<sup>5</sup> Similarly, a study with HCPs showed that 74–79% of HCPs misclassified toddlers with overweight as having a healthy weight.<sup>6</sup> These findings can be explained by the visual normalisation theory of overweight, proposing that the “threshold” for what is considered overweight has increased in line with population prevalence leaving overweight as “unseen”.<sup>7</sup> The misperception of weight status carries significant implications, with parents less likely to adopt healthy lifestyle changes for children when excess weight goes unrecognised.<sup>8</sup>

At present, HCPs rely on the WHO Standard Growth Charts<sup>9</sup> to track and communicate childhood weight development. These charts are widely implemented<sup>10</sup> but parents report confusion towards them due to their numerical complexity.<sup>11</sup> In one experimental study ( $n = 1000$ ) 77% of parents incorrectly interpreted the results of growth charts, despite 79% reporting familiarity with the tool.<sup>12</sup> Hence, growth charts alone may be insufficient to engage caregivers in conversations about bodyweight.<sup>13</sup>

A newly developed 3D body size scale (3D BSS) provides a visual representation of body shape variation across the weight spectrum and may help support such conversations.<sup>14</sup> The 3D BSS presents anatomically correct models of a female and male child, morphed from 211 body scans, ranging from underweight to very overweight categories. In contrast to previous visual models of weight status which have largely relied on subjective artists' sketches of differing body size, the 3D BSS is the first to align with the British 1990 child growth reference data, making it suitable for use in the UK.<sup>15</sup> In a previous study, the 3D BSS of 4–5-year-olds was sent to parents alongside the National Child Measurement Programme (NCMP) feedback letter and was shown to double the uptake of a child-weight-management service.<sup>16</sup> Additional qualitative work undertaken during the development of the 3D BSS demonstrated acceptability and utility of the 3D BSS for facilitating engagement between parents ( $n = 33$ ) and health care professionals.<sup>14</sup> These findings suggest that applying a similar 3D BSS for toddlers into routine pediatric conversations may aid understanding of weight development and thereby increase engagement with beneficial health behaviours.

Prior to such development and implementation, it is crucial to evaluate the acceptability and feasibility of delivering the 3D BSS to families of toddlers and explore potential risk for negative psychosocial consequences. There has also been limited research exploring parental preferences for early weight-related conversations, despite the routine nature of these discussions through the UK-wide 2-year

Child Development Check.<sup>17</sup> Therefore, the current “Healthy Toddler Study” (HTS) aimed to explore caregivers perspectives towards integration of a 3D BSS into pediatric appointments. The current paper will highlight relevant barriers and facilitators to engagement with the 3D BSS, as well as with conversations regarding child weight patterning more generally. A mixed-methods approach was employed to explore the following research questions:

1. Is it acceptable to present caregivers with a 3D BSS to initiate conversations about toddler weight within a routine pediatric appointment?
2. What are the barriers and facilitators to caregivers' engagement with a 3D BSS of toddler weight within a routine pediatric appointment?

## 2 | METHODS

A mixed-methods design was employed. Qualitative and quantitative data collection occurred simultaneously, and findings were converged for cross-validation<sup>18</sup>. The UCL Research Ethics Committee granted ethical approval for this study (Project ID: 8221/001).

### 2.1 | Participants

Participants for the current study had to be the primary guardian of at least one 2-to-4-year-old child and reside in the UK. Recruitment occurred through snowball sampling on social media (Facebook, Twitter). A separate group of participants ( $n = 3$ ), subject to the same inclusion criteria, were recruited to pilot the study materials. Following this pilot, 68 eligible participants expressed interest, of which 38 completed the HTS procedures. Participants provided informed consent and were provided £25 vouchers.

### 2.2 | Materials & Procedure: Quantitative Phase

Participants ( $n = 38$ ) were asked to complete two online questionnaires on REDcap, a secure online survey management platform.<sup>19</sup> The baseline questionnaire was provided through an email link a week before the interview, and the second questionnaire directly post-interview. Questionnaires were completed remotely online. The baseline questionnaire collected demographic and anthropometric information including caregiver sex, age, height, weight, educational attainment, ethnicity and number of children, as well as their toddler's age, sex, height, and weight. In the post-interview questionnaire, participants were asked to i) rate the acceptability of being offered the 3D BSS by a HCP (7-point Likert Scale, “very acceptable” to “very unacceptable”) and ii) rate whether they felt their understanding of child weight development had improved after being introduced to the 3D BSS (7-point Likert Scale; “very improved” to “very decreased”).

## 2.3 | Materials & Procedure: Qualitative Phase

### 2.3.1 | Vignette Interview

The semi-structured interview schedule was designed in line with the Interview Protocol Refinement Framework.<sup>20</sup> Interviews (36/38; 95%) were undertaken over the phone, with two interviews undertaken in-person to suit the participants' preference. The researcher read aloud to participants a vignette describing a fictional routine 2-year Child Development Check appointment.<sup>17</sup> The vignette depicted this appointment with a mother, a female toddler and a Health Visitor for all participants. For the full vignette see Figure S1. Participants were asked to respond how they believed the mother in the vignette would feel and act in the story, exploring the sensitive topic of toddler weight in a less personal manner.<sup>20</sup> For the full interview schedule see Figure S2. This design also enabled exploration of how parental responses may vary by two manipulated factors, (a) the weight status of the toddler in the vignette (underweight, healthy weight, and overweight) and (b) the order in which visual tools were presented by the Health Visitor (UK-WHO growth chart for girls 0–4 vs. 3D BSS). Overall, this design resulted in six different vignette conditions (eg, 3D BSS presented first, with a toddler of overweight only) to which participants were randomly allocated. For full details of conditions see Figure S3. Two relevant experts in child development and one clinician were consulted to ensure the authenticity of the vignette.

### 2.3.2 | Visual study pack

Participants received an electronic "HTS study pack" over email ( $n = 36$ ) or on paper ( $n = 2$ ), depending on the setting of interview. See Figure S4. This pack included two visual prompts: (1) a UK-WHO growth chart for girls 0–4<sup>9</sup> and (2) the female 3D BSS of 4–5-year-old children. This 3D BSS was developed by obtaining KX-16 3D surface body scans and anthropometric measurements of 4–5-year-old children ( $n = 211$ ). These scans were subsequently morphed, using V5 and M5 morphs (from [www.daz3d.com](http://www.daz3d.com)) to create models representative of each BMI category and intended to depict children of no specific ethnicity. For the full 3D BSS see Figure S4.<sup>14</sup> When introduced to the 3D BSS, participants were directed towards the image on the 3D BSS relevant to their allocated weight condition (underweight, healthy weight, overweight).

The 3D BSS of 4–5-year-old children was provided as an equivalent stand-in visual tool, given that at the time of the present HTS study, the 2–3-year-old BSS images were under development. The insights of the present HTS study were intended to inform the design and refinement of the toddler 3D BSS. As this study aimed to explore caregivers' general acceptance of a 3D BSS in the context of a routine consultation, as opposed to their views of the presentation, design and appearance of the tool itself, it was decided this stand-in tool was adequate. Moreover, during piloting of the study materials, the older age of the 3D BSS was undetected ( $n = 3$ ). The insights of the present HTS study were also used

**TABLE 1** Participant characteristics for caregivers in the Healthy Toddler Study ( $n = 38$ )

Sample characteristics	n (%)
Gender	
Female	35 (92%)
Male	3 (8%)
Ethnicity	
White	31 (81%)
Caribbean	1 (3%)
African	1 (3%)
Asian	2 (5%)
Other	3 (8%)
Education	
GCSE or 'O' Level or Vocational Qualification	3 (8%)
A or AS level	1 (3%)
Undergraduate or postgraduate	34 (89%)
Age [years]	
25–29	4 (11%)
30–34	8 (21%)
35–39	18 (47%)
40–45	8 (21%)
Guardian BMI [ $\text{kg}/\text{m}^2$ ] <sup>a</sup>	
$\leq 18.5$ (underweight)	2 (5%)
18.5–24.9 (healthy weight)	20 (53%)
25–29.9 (overweight)	8 (21%)
$\geq 30$ (obese)	8 (21%)
Number of children	
1	16 (42%)
2	15 (40%)
3	7 (18%)
Age of children [years]	
1–2	3 (8%)
2–3	24 (63%)
3–4	11 (29%)
Toddler BMI percentile <sup>a,b</sup>	
$\leq 5$ percentile (underweight)	4 (11%)
5–85 percentile (healthy weight)	19 (50%)
85–95 percentile (overweight)	5 (13%)
95 $\leq$ percentile (very overweight)	5 (13%)
Attendance of 2-year Health and Development Review prior to interview	
Have Attended	26 (68%)
Did Not Attended	12 (32%)

<sup>a</sup>BMI = Body Mass Index ( $\text{kg}/\text{m}^2$ ); calculated from self-reported body weight (kg) and height (cm).

<sup>b</sup>Two participants were parents to two toddlers, height (cm), weight (kg) and age data (months) were used to calculate BMI percentiles with reference to the UK90 cut points (Cole et al, 1995).

<sup>c</sup>3D Body Size Scale of 4 to 5-year-old-children (3D BSS).

**TABLE 2** Caregiver acceptability of 3D Body Size Scale (BSS) in the Healthy Toddler Study (n = 38)

Factors affecting acceptability of the 3D BSS	n (%)	p-value <sup>a</sup>
Overall acceptability of 3D BSS <sup>b</sup>		
Very Acceptable (1)	20 (52.6%)	
Moderately Acceptable (2)	12 (31.6%)	
Slightly Acceptable (3)	3 (7.9%)	
Undecided (4)	1 (2.6%)	
Slightly Unacceptable (5)	0 (0%)	
Moderately Unacceptable (6)	1 (2.6%)	
Very Unacceptable (7)	1 (2.6%)	
Understanding of toddler weight status following 3D BSS <sup>b</sup>		
Very Improved	8 (21.1%)	
Moderately Improved	6 (15.8%)	
Slightly Improved	8 (21.1%)	
Neither	13 (34.4%)	
Slightly Decreased	2 (5.3%)	
Moderately Decreased	0 (0%)	
Very Decreased	1 (2.6%)	
	Mean (SD)	
Acceptability of 3D BSS score <sup>b</sup> by depicted toddler weight status		
Underweight	1.69 (1.38)	0.62
Healthy Weight	2.18 (1.78)	
Overweight	1.71 (0.91)	
Acceptability of 3D BSS score <sup>b</sup> by caregiver weight status		
Underweight ( $\leq 18.5$ BMI <sup>c</sup> )	1 (0.00)	0.74
Healthy Weight ( $< 25$ BMI <sup>c</sup> )	1.75 (0.72)	
Overweight ( $< 30$ BMI <sup>c</sup> )	2 (1.69)	
Obese ( $\geq 30$ BMI <sup>c</sup> )	2.13 (2.23)	

<sup>a</sup>Difference in mean values between groups were tested using one-way ANOVA.

<sup>b</sup>3D Body Size Scale of 4 to 5-year-old-children.

<sup>c</sup>BMI = Body Mass Index ( $\text{kg}/\text{m}^2$ ); calculated from self-reported body weight (kg) and height (cm).

to refine the design of the toddler 3D BSS. For further details of how the 3D BSS was presented to study participants, see Figure S2.

## 2.4 | Analyses

Verbatim transcription of 38 interviews was undertaken by an external transcription company (Devon Transcriptions Ltd.). Transcripts were analysed using deductive thematic analysis, using a realist epistemology, and adhered to the stepped approach as set out by Braun and Clarke.<sup>21</sup> Interview transcripts were coded independently by two researchers (KT and AS), and subsequent inter-rater reliability indicated fair to good agreement ( $\alpha = 0.66$ ) in a double coded subset

(n = 8, 21%). NVivo V12<sup>22</sup> was used to store and organise codes throughout the analyses. Acceptability was measured using a 7-point acceptability Likert-scale which was treated as continuous, assuming equidistance between points.<sup>23</sup> One-way ANOVA's were conducted to compare differences in mean 3D BSS acceptability scores by i) the weight status of the toddler depicted in the vignette and ii) the weight status of the caregiver being interviewed. To account for potential presentation order effects, the order of chart presentation to the vignette parent (UK-WHO growth chart first vs 3D BSS first) was randomly allocated. This final sample size was sufficient to achieve statistical power for any between group comparisons (n = 5 per group) with an alpha = 0.05, power = 0.80 and medium effect size (f = 0.25).<sup>4</sup> P-values of <0.05 were considered statistically significant. All statistical analyses were undertaken in SPSS version 22.<sup>24</sup>

## 3 | RESULTS

### 3.1 | Characteristics of study participants

A sample of 38 caregivers were recruited, consisting of 35 mothers and 3 fathers (8%). Participants were mostly of white ethnicity (n = 31; 81%) and highly educated (n = 34; 89% with university-level education). Participant demographic details are presented in Table 1.

### 3.2 | Acceptability of 3D body size scales

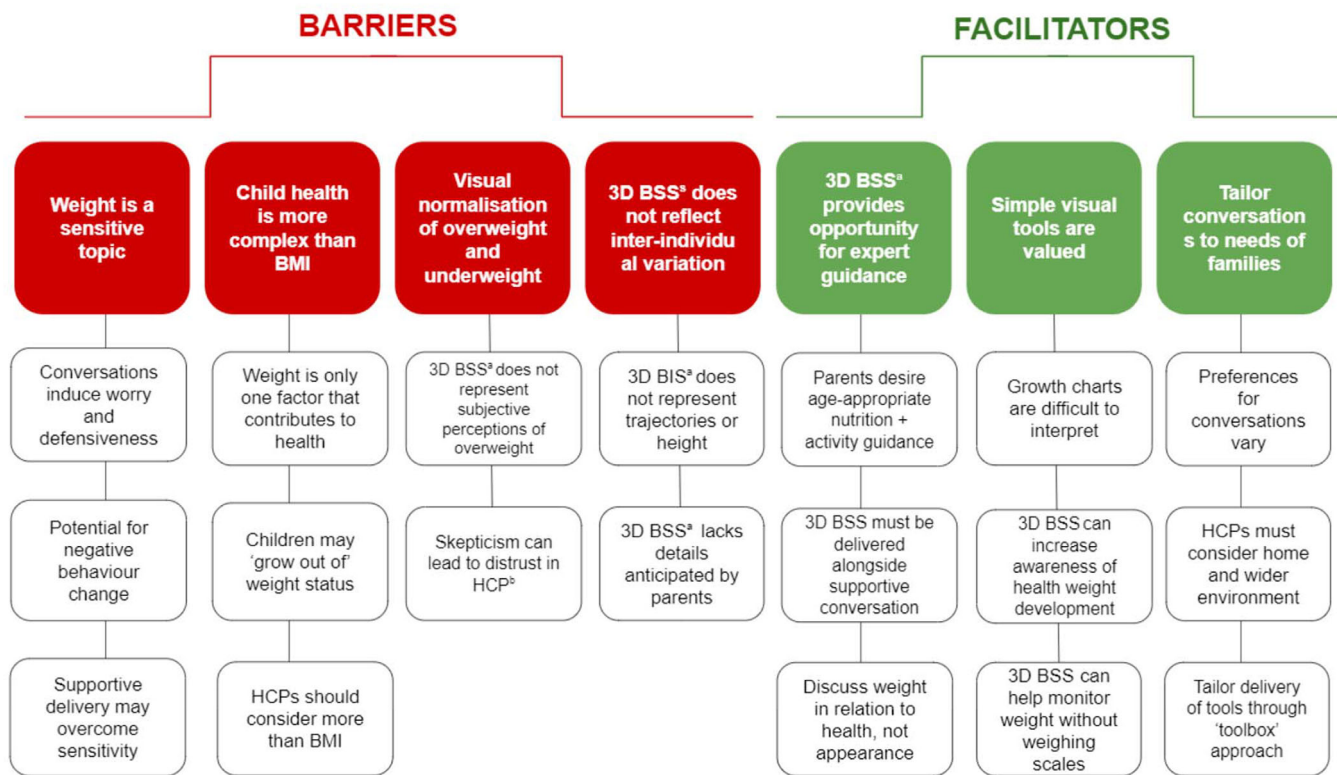
The 3D BSS was rated as moderately ("Moderately Acceptable"; n = 12, 31.6%) to very acceptable ("Very Acceptable"; n = 20, 52.6%). Few caregivers (n = 2; 5%) considered the 3D BSS as "moderately unacceptable" or "very unacceptable". There was a no effect of the vignette toddler's weight status (P = 0.62) or caregivers weight status (P = 0.74) on 3D BSS acceptability. Full details of acceptability scores by weight status condition are shown in Table 2.

### 3.3 | Thematic analysis

Seven key themes were identified from deductive thematic analysis. These consisted of four key "barriers" and three "facilitators" concerning caregivers' acceptance of the 3D BSS as a visual tool for use during routine pediatric appointments. These themes and subthemes are represented in Figure 1.

#### 3.3.1 | Barrier 1: Weight is a sensitive topic

Caregivers expressed the desire to discuss toddler weight development with a relevant and knowledgeable HCP (Quote 1; Q1). Many parents however voiced concern that childhood weight is a sensitive issue which should be discussed with care (Q2). Parents spoke of feelings such as guilt, defensiveness, and worry, which arise when told of



**FIGURE 1** Map of themes and subthemes identified in the Healthy Toddler Study. Note: Themes describe caregivers (n = 38) perspectives towards the facilitators and barriers to using the 3D Body Size Scale to within routine pediatric conversations regarding early child weight patterning. <sup>a</sup> 3D BSS = 3D Body Size Scale of 4 to 5-year-old-children. <sup>b</sup> HCPs = Health Care Professionals. <sup>c</sup> GPs = General Practitioners

children falling outside of the healthy weight range (Q3). Some parents also voiced apprehension that the 3D BSS may result in negative actions by worried caregivers, such as restrictive feeding, and the potential to make children self-conscious from an early age (Q4). Nevertheless, the majority of the caregivers believed that outcomes would depend on the manner in which the 3D BSS was delivered (Q5). For relevant quotes, see Table 3.

### 3.3.2 | Barrier 2: Child health is more complex than BMI

Many caregivers expressed their belief that a child's weight status is one of many factors that contribute to child health (Q6). Therefore, if a child's BMI falls outside of the healthy weight range, they should not automatically be classed as unhealthy. They may be engaging with health behaviours (Q7) or may be carrying "puppy fat" (Q8). Some parents discussed the rapidly changing nature of child weight, stating that children will likely grow out of overweight or underweight (Q9). The act of labelling children's weight status based on a single BMI measurement was considered too simplistic (Q10). Parents wished for the breadth of factors that contribute to child weight development to be considered alongside weight measurements during discussions with HCPs (Q11). For relevant quotes, see Table 4.

### 3.3.3 | Barrier 3: Visual normalisation of overweight and underweight in childhood

Parental preconceptions of what underweight and overweight "look like" in children often did not align with the objective presentation in the 3D BSS (Q12). Most caregivers said they did not perceive significant visual differences across weight statuses in the 3D BSS (Q13). Participants believed this apparent absence of noticeable variability in body size may result in dismissal of the 3D BSS (Q14). In some cases, parents believed that the provision of "unrealistic" images could result in families losing trust in the HCP and accompanying information (Q15). For relevant quotes, see Table 5.

### 3.3.4 | Barrier 4: The 3D BSS does not reflect inter-individual variation in development

Many caregivers felt the 3D BSS did not reflect children's inter-individual variation in growth (Q16) or height development (Q17). This concern was reflective of underlying scepticism of BMI measurements in general, as parents felt these "simple" calculations did not reflect variation in healthy development (Q18). Caregivers suggested 3D BSS could be improved by stating the threshold values that define weight status categories (Q19). Some caregivers felt the 3D BSS was also limited

**TABLE 3** Quotes relating to Barrier 1: Child weight is a sensitive topic

Barrier 1: Weight is a sensitive topic	
Quote #	
1	"I mean, it [Overweight] should be something to be aware of, definitely... I think it should be mentioned in a way that is giving information rather than calling the child obese." Participant 9, Mother of 1, Age 38
2	"This is a very sensitive issue... I'm not saying they should not use the word overweight but just they are going to have to be very careful and sensitive about how they have this conversation with Helen" Participant 53, Mother of 3, Age 40
3	"She probably would be feeling like a useless mother thinking that maybe she is giving her child too much food and that she is making her overweight, so probably feeling guilty like it's [overweight] her fault" Participant 47, Mother of 2, Age 42
4	"She could very much be influenced by these pictures and she could get concerned if Anna is getting more towards the left or more towards the right of these photographs and that could be passed on to Anna, which is the very last thing you would ever want to do for a child, is to make them aware of their body shape in a concerned way." Participant 30, Mother of 2, Age 43
5	I think depending on what the health visitor was discussing in terms of underweight and overweight my reaction would be different. Participant 52, Mother of 1, Age 35

**TABLE 4** Quotes relating to Barrier 2: Child health is more complex than BMI

Barrier 2: Child health is more complex than BMI	
Quote #	
6	"Every child is obviously different and there are lots of factors that should be considered when thinking about the overall kind of health and weight of your child" Participant 54, Mother of 2, Age 33
7	"I think if my son is in the 'very overweight' category, I am okay with that, because I still think he is healthy. He is active, he eats healthy food." Participant 24, Mother of 1, Age 42
8	"and also some children are just bigger, they have got puppy fat and things, and they are not fat, as in obese, but they might just tip the scale a little bit." Participant 32, Mother of 1, Age 37
9	"The underweight kid could have been me when I was that age and I was perfectly fine. And at the same time, the overweight could be my son and he is absolutely healthy as a fiddle." Participant 40, Mother of 1, Age 32
10	"But the idea of putting a picture and putting 'overweight' on it, putting a label on a child. I mean, they are children..." Participant 40, Mother of 1, Age 32
11	"I think there are a whole lot of pieces of information that should be understood prior to giving a diagnosis, or a judgement, that a child is overweight, because that can be incredibly dangerous." Participant 26, Father of 2, Age 39

**TABLE 5** Quotes relating to Barrier 3: Visual normalisation of overweight and underweight in childhood

Barrier 3: Visual normalisation of overweight and underweight in childhood	
Quote #	
12	"Overweight does not look that overweight to be perfectly honest. It does not look like it's a concern in those pictures [3D BSS], even very overweight still looks a bit baby fat, [laughs] if you know what I mean, toddler chub that they'll grow out of, 'Isn't it cute?'" Participant 53, Mother of 3, Age 40
13	"They do not look that much different [in 3D BSS]. You might just go 'She's alright, I do not see the problem there.'" Participant 51, Mother of 3, Age 41
14	"I do not think she would be affected that much, because underweight does not look too bad [laughs]. Yes." Participant 9, Mother of 1, Age 38
15	"I just think that some parents, if they feel that the healthcare information that's provided to them is a bit too unrealistic, they stop trusting it anymore." Participant 55, Mother of 1, Age 38

**TABLE 6** Quotes relating to Barrier 4: The 3D Body Size Scale does not reflect inter-individual variation in development

Barrier 4: The 3D Body Size Scale does not reflect inter-individual variation in development	
Quote #	
16	"Children do not all distribute their fat in the same way, they are going to look different in their shorts, and overweight, if they are tall and overweight or vice versa" Participant 52, Mother of 1, Age 35
17	"They all have the same height, these kids, and so they are not a realistic presentation of the population range... So I would find it difficult to compare it to a real child. If I had a child that was particularly short or particularly tall, they would not really fit in these images probably." Participant 43, Mother of 2, Age 38
18	"To be honest I think BMI, and this might just be me, is such an old... People do not really view it in the same way people tend to feel like it's maybe a little bit irrelevant... and maybe saying the healthy waist measurement... That kind of thing might be more useful." Participant 50, Mother of 2, Age 38
19	"I would ask, 'How have you measured? What is healthy weight? What are the categories for healthy weight? How many feet and how many inches? What is the BMI? What are the metrics for healthy weight and what are the metrics for overweight?'" Participant 5, Father of 2, Age 34
20	"For a one-off measurement it gives you some information, but perhaps not that much information because you are just checking at one point in time. If she then uses it over a longer period of time, she could see how the height and weight progress and whether they remain on the same centile or whether they go up and down" Participant 7, Mother of 2, Age 29

in its ability to account for a child's previous developmental trajectory, meaning the 3D BSS may be perceived as a simplistic snapshot of weight development (Q20). For relevant quotes, see Table 6.

### 3.3.5 | Facilitator 1: The 3D BSS provides opportunity for expert guidance

All caregivers voiced a desire to discuss child weight development with an appropriate HCP (Q21). Participants believed that introduction of the 3D BSS could initiate a much-needed opportunity to provide families with childhood nutrition and exercise guidance (Q22). Parents also mentioned that engagement with the tool would be dependent upon the tone of the language and type of phrases used (Q23). Parents expressed preference for the 3D BSS and toddler weight development to be discussed specifically in relation to implications for child health (Q24), along with supportive, non-judgemental and feasible guidance. Parents expressed preference for the 3D BSS and toddler weight development to be discussed specifically in relation to implications for child health (Q24), along with supportive, non-judgemental and feasible guidance. Such a sensitive and informative approach was deemed more important to acceptability than the type of HCP providing the weight feedback alongside the 3D BSS (eg, health visitors vs paediatricians). For relevant quotes, see Table 7.

**TABLE 7** Quotes relating to Facilitator 1: The 3D Body Size Scale provides opportunity for expert guidance

Facilitator: The 3D Body Size Scale provides opportunity for expert guidance	
Quote #	
21	"Parents are really worried about things like that [Weight], so the more information they get the better" Participant 55, Mother of 1, Age 38
22	"Rather than just saying, "You have an overweight child," [Health Visitor] should talk to the parent and try to understand what they are giving their child, how they are living, what lifestyle they are doing, to then make their parent think about, "Am I making the right choices for my child?" Participant 27, Mother of 1, Age 39
23	"Both the pictures and the growth chart are a tool for the health visitor to enable them to have that conversation with the parent. ... it's more about being supportive and recognising how the parent is reacting. Just telling them that their child is overweight... is probably not going to be very helpful." Participant 53, Mother of 3, Age 40
24	"Maybe this should be also accompanied by health risks because it is not just about the image. It is not just about how you look, it is about what is the problem if you look like this." Participant 5, Mother of 1, Age 35

### 3.3.6 | Facilitator 2: Simple visual tools are valued

Many caregivers reflected on child weight as a complex subject (Q25). Participants largely saw standard BMI charts as an overly complicated tool that could overwhelm (Q26). In comparison, the visual 3D BSS was seen as a more "relatable" and "simple" tool (Q27) that can aid to clarify the growth charts (Q28). Some participants believed the 3D BSS could increase parents' awareness of the subtle differences between weight categories (Q29) resulting in positive behaviour change where appropriate (Q30). For relevant quotes, see Table 8.

### 3.3.7 | Facilitator 3: Tailor conversations to the individual needs of families

Caregivers believed that families vary greatly in their preferences regarding child weight discussions. These important conversations

**TABLE 8** Quotes relating to Facilitator 2: Simple visual tools are valued

Facilitator 2: Simple visual tools are valued	
Quote #	
25	"It's very difficult with your own child to know context with your child in the context of other children and what is considered to be a normal height/weight ratio for a child of that age" Participant 52, Mother of 1, Age 35
26	"Yes, it [Growth Charts] is a lot of information so if a person does not have that knowledge base, it is all very frightening. You will be thinking, what do all these numbers mean?" Participant 8, Mother of 1, Age 33
27	"I think just because it [3D BSS] is more relatable. It does not feel like an 'us and them' situation when it comes to what knowledge you would need to really understand it. Everybody can understand this picture, regardless." Participant 33, Mother of 3, Age 28
28	"I suppose if you were not very good with the graph [Growth Charts] and things like that these ones [The 3D BSS] would be really helpful because you can visualise the child and hold the paper near them and know where you are" Participant 56, Father of 1, Age 30
29	"I think the pictures [3D BSS] are more powerful, even though I could not see the difference between just looking at the... I think that is even important. You do not see that much of a difference but still she could be unhealthy... So in the picture, when you look at your child, she does not look unhealthy compared to the other children but it should still be considered as an unhealthy, underweight child. So that was interesting" Participant 9, Mother of 2, Age 38
30	"I think for a lot of people it may make the information much more understandable than just the growth charts. That may have a scary implication if it really brings home the truth, but then that surely is beneficial if it changes the behaviour as a result." Participant 46, Mother of 2, Age 37

**TABLE 9** Quotes relating to Facilitator 3: Tailor conversations to the individual needs of families

Facilitator 3: Tailor conversations to the individual needs of families	
Quote #	
32	"I would say that any health visitor that goes and has these conversations has to be very aware of the person they are talking to." Participant 26, Father of 2, Age 39
33	"Do not jump to the conclusion 'You have an overweight child, you have done something wrong, now we have to fix it.' Just ask more questions and try to understand what lies behind the fact that the child is overweight, or potentially overweight." Participant 55, Mother of 1, Age 38
34	"I think it's so specific to each individual case. If the health visitor was going out with a set of that they could pick and choose from and show the parent and they could judge it on each individual case, then that would be great, if they had a toolbox." Participant 52, Mother of 1, Age 35
35	"Yeah. I mean, I think health visitors, they are savvy enough to gauge whether that would be well-received or not. And I think if they feel like it [3D BSS] would not be well-received and maybe not say it, that is a shame but I guess it would be at their discretion." Participant 33, Mother of 3, Age 28

would be more engaging if HCPs developed an understanding of the family's background and preferences prior to offering guidance (Q32). For example, HCPs could consider factors in the home environment (eg, number of siblings) as well as the wider structural environment of the family (eg, access to shops) whilst discussing weight patterning (Q33). Parents also mentioned the 3D BSS would be of most benefit if delivered as part of a multicomponent "toolbox" of resources, including the growth charts (Q34). Equipping HCPs with numerous resources would allow for tailoring of these discussions to better meet the needs of caregivers (Q35). For relevant quotes, see Table 9.

## 4 | DISCUSSION

The current study aimed to evaluate the acceptability and feasibility of integrating a 3D BSS into routine healthcare conversations about toddler weight development between HCPs and caregivers. Combining the results from the interviews and questionnaires, the 3D BSS was considered an acceptable resource if delivered in a sensitive and personalised manner.

### 4.1 | Acceptability of the 3D BSS

Caregivers found the 3D BSS to be a "moderately" to "very" ( $n = 32/38$ ; 84.2%) acceptable resource. Acceptability did not differ by the weight status of the child in the vignette or the caregivers

interviewed. Acceptability was contingent upon a number of barriers and facilitators.

### 4.2 | Barriers to the acceptability of the 3D BSS

Findings from the present study emphasized that overweight in toddlerhood is a highly sensitive matter where caregiver worry and defensiveness may influence discussion. Previous findings show that such 'defensiveness' can lead nurses to avoid weight-related conversations.<sup>25</sup> Caregivers in the current sample mentioned that such emotions could be reduced if conversations are positively-framed and supplemented with actionable advice. Some participants also believed that BMI measurements are oversimplified, and HCPs should consider individual developmental trajectories and health behaviours, when presenting the 3D BSS.

As proposed in visual normalisation theory<sup>7</sup>, parents often perceived the 3D BSS to be an "unrealistic" depiction of overweight and underweight in children. Similar to the findings of Jones et al,<sup>14</sup> parents could easily dismiss the tool and disengage from discussions for this reason. To prevent this, HCPs may wish to highlight the accuracy of the tool. Many caregivers also believed the 3D BSS neglected individual growth patterning over time. This common criticism supports the joint delivery of the 3D BSS and growth charts, where such "tracking" is possible. Whilst not explicitly explored in the context of this study, the importance of increasing representation of a wider range of ethnicities in the 3D BSS was raised. Parents suggested this would increase the perceived relevance of the tool and understanding of the importance of healthy body weight for optimal child health across communities of all ethnic backgrounds.

### 4.3 | Facilitators to the acceptability of the 3D BSS

Participants believed the 3D BSS provided a welcome opportunity to discuss toddler weight development.<sup>26,27</sup> Equipping HCPs with multiple tools, such as the 3D BSS, may help facilitate constructive weight-related conversations between caregivers and HCPs. However, previous studies have demonstrated that nurses feel ill equipped to offer such guidance and desire clearer protocols.<sup>13,28</sup> Further research with HCPs is needed to investigate whether the 3D BSS can help address these needs. Finally, participants believed the guidance provided by HCPs should be tailored to familial needs as a "one size fits all" approach was rejected. This finding aligns with McPherson et al's suggestion<sup>26</sup> to use a staged approach, supporting the development of a "toolbox" of resources to maximise interactions between caregivers and the healthcare system.

### 4.4 | Limitations and Strengths

Various strengths and limitations must be considered in relation to this study. First, the mixed methods approach allowed for integration



of quantitative and qualitative insights on a complex topic. However, the parents recruited to this study mostly consisted of highly educated, white mothers. Hence, the views and opinions of the current sample might differ systematically from those of the general population.<sup>29</sup> Moreover, the provision of the 4–5-year-old 3D BSS in this study prevents firm conclusions about the toddler 3D BSS' suitability for incorporation into the 2-year Child Development Check as differences in weight distributions may exist between the scales. Nonetheless, the present study provides the first evidence that such a 3D scale is a generally acceptable tool to discuss toddler weight in the eyes of caregivers, justifying the development of the toddler 2–3 year old 3D BSS and subsequent acceptability testing.

Nonetheless, this study benefits from its novel focus on early childhood, as early weight development is predictive of future adiposity.<sup>2</sup> In line with current clinical guidelines, discussion of weight development and regular plotting of BMI from early childhood is warranted.<sup>30–32</sup> 3D BSSs offer potential as a novel means for facilitating such conversations which in turn could lead to greater promotion of strategies to counter rapid weight gain in early childhood. The 3D BSS could be integrated into existing frameworks for weight monitoring. Parents often do not “see” their child's weight status objectively, but the 3D BSS may help overcome this issue by enabling parents to see their child's weight status in context. Clearer perception of their child's weight may also increase caregivers' receptivity to information on intervention and prevention strategies. Moreover, a considerable proportion of health personnel are uncomfortable with initiating conversations about a child's weight status. Being able to use a hard copy or digital version of the 3D BSS (eg, on a tablet) may provide a practical and supportive tool to broach the sensitive topic of child weight in the context of a routine healthcare appointment.<sup>33</sup>

## 5 | CONCLUSION

The present feasibility study indicated that 3D Body Size Scales may be an acceptable tool to engage caregivers in conversations regarding early childhood weight development, if they are accompanied by tailored and sensitive guidance from HCPs. There are multiple implications of these findings. First, delivery of the 3D BSS may provide a feasible method to address the visual “normalisation of overweight” among parents. Second, the insights presented may help inform the development of a wider “toolbox” of materials to facilitate routine conversations regarding child weight patterning (eg, a suitable conversation guide). Nonetheless, previous literature has focused on nurses and GPs, meaning further exploration of Health Visitors' perspectives towards conversations is warranted. Future research must also specifically investigate the potential and acceptability of the 2–3-year old toddler 3D BSS, once developed.

## ACKNOWLEDGMENTS

KT and ADS conceived the data collection instruments, carried out the interviews, conducted qualitative data analysis, and drafted the initial manuscript. KT led on the quantitative analysis. MT contributed

to the development of the 3D body size scales. EE, HC and CL provided feedback on the design of the data collection tools, provided critical feedback on the interpretation of the results, and reviewed and revised the manuscript multiple times. AS provided critical feedback on the final manuscript. All authors were involved in the conceptualisation of the study, writing of the paper and had final approval of the submitted and published versions of the manuscript. The authors would like to thank the participants for their time and efforts taking part in the study, and Ms Catalina Trama Alvarez (UCL) for her assistance in conducting the interviews.

## CONFLICT OF INTEREST

The authors have indicated they have no potential conflicts of interest to disclose.

## FINANCIAL DISCLOSURE

The authors have indicated they have no other financial relationships relevant to this article to disclose.

## ORCID

Kristiane Tommerup  <https://orcid.org/0000-0001-6125-3683>

Andrea D. Smith  <https://orcid.org/0000-0002-6925-6667>

Elizabeth H. Evans  <https://orcid.org/0000-0002-3432-3778>

Helen Croker  <https://orcid.org/0000-0002-7247-6599>

Andrew Steptoe  <https://orcid.org/0000-0001-7808-4943>

Martin J. Tovee  <https://orcid.org/0000-0001-9642-4462>

Alison Fildes  <https://orcid.org/0000-0002-5452-2512>

Clare Llewellyn  <https://orcid.org/0000-0002-0066-2827>

## REFERENCES

1. Finucane MM, Stevens GA, Cowan MJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet*. 2011;377(9765):557–567. [https://doi.org/10.1016/S0140-6736\(10\)62037-5](https://doi.org/10.1016/S0140-6736(10)62037-5).
2. Geserick M, Vogel M, Gausche R, et al. Acceleration of BMI in early childhood and risk of sustained obesity. *N Engl J Med*. 2018;379(14):1303–1312. <https://doi.org/10.1056/NEJMoa1803527>.
3. Nader PR, O'Brien M, Houts R, et al. Identifying risk for obesity in early childhood. *Pediatrics*. 2006;118(3):e594–e601. <https://doi.org/10.1542/peds.2005-2801>.
4. Lundahl A, Kidwell KM, Nelson TD. Parental underestimates of child weight: a meta-analysis. *Pediatrics*. 2014;133(3):e689–e703. <https://doi.org/10.1542/peds.2013-2690>.
5. Rietmeijer-Mentink M, Paulis WD, van Middelkoop M, Bindels PJE, van der Wouden JC. Difference between parental perception and actual weight status of children: a systematic review. *Matern Child Nutr*. 2013;9(1):3–22. <https://doi.org/10.1111/j.1740-8709.2012.00462.x>.
6. Bocca G, et al. Healthcare professionals' perception of overweight in preschool-aged children. L. A, ed. *Horm Res Paediatr*. 2015;84(SUPPL. 1):431–432. doi:<https://doi.org/10.1159/000437032>
7. Robinson E. Overweight but unseen: a review of the underestimation of weight status and a visual normalization theory. *Obes Rev*. 2017;18(10):1200–1209. <https://doi.org/10.1111/obr.12570>.
8. Rhee KE, De Lago CW, Arscott-Mills T, Mehta SD, Davis RK, Horlick M. Factors associated with parental readiness to make

- changes for overweight children. *Pediatrics*. 2005;116(1):e94-e101. <https://doi.org/10.1542/peds.2004-2479>.
9. RCPCH. *UK-WHO growth charts—0-4 years* <https://www.rcpch.ac.uk/resources/uk-who-growth-charts-0-4-years>. Geneva: World Health Organization (WHO); 2019.
  10. Edvardsson K, Edvardsson D, Hörnsten Å. Raising issues about children's overweight - maternal and child health nurses' experiences. *J Adv Nurs*. 2009;65(12):2542-2551. <https://doi.org/10.1111/j.1365-2648.2009.05127.x>.
  11. Gillison FB, Lorenc AB, Sleddens EFC, Williams SL, Atkinson L. Can it be harmful for parents to talk to their child about their weight? A meta-analysis. *Prev Med (Baltim)*. 2016;93:135-146. <https://doi.org/10.1016/j.ypmed.2016.10.010>.
  12. Ben-Joseph EP, Dowshen SA, Izenberg N. Do parents understand growth charts? A national, internet-based survey. *Pediatrics*. 2009;124(4):1100-1109. <https://doi.org/10.1542/peds.2008-0797>.
  13. Bradbury B, Wiley J, Bradbury D, et al. Barriers and facilitators to health care professionals discussing child weight with parents: a meta-synthesis of qualitative studies. *Br J Heal Psychol*. 2018;23(3):701-722. <https://doi.org/10.1111/bjhp.12312>.
  14. Jones AR, Tovée MJ, Cutler LR, et al. Development of the MapMe intervention body image scales of known weight status for 4-5 and 10-11 year old children. *J Public Health (Oxf)*. 2018;40(3):582-590. <https://doi.org/10.1093/pubmed/idx129>.
  15. Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK, 1990. *Arch Dis Child*. 1995;73:25-29.
  16. Sallis A, Porter L, Tan K, et al. Improving child weight management uptake through enhanced National Child Measurement Programme parental feedback letters: a randomised controlled trial. *Prev Med (Baltim)*. 2019;121:128-135. <https://doi.org/10.1016/J.YPMED.2019.01.023>.
  17. NHS.uk. Your baby's health and development reviews - NHS. <https://www.nhs.uk/conditions/pregnancy-and-baby/baby-reviews/>. Published 2017. Accessed August 17, 2019.
  18. Creswell JW. *Research design: qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications; 2003. <https://pdfs.semanticscholar.org/73b7/18e508fa943dfb22a9cb5fb17f888239ad0e.pdf>. Accessed August 17, 2019.
  19. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform*. 2019;95:103208. <https://doi.org/10.1016/j.jbi.2019.103208>.
  20. Castillo-Montoya M. Preparing for interview research: the interview protocol refinement. *The Qualitative Report*. 2016;21(5):811-831. <http://nsuworks.nova.edu/tqr/vol21/iss5/2> Accessed August 8, 2019.
  21. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77-101. <https://doi.org/10.1191/1478088706qp063oa>.
  22. NVivo qualitative data analysis software; QSR International Pty Ltd. Version 12, 2018. <https://docs.google.com/document/d/1KZ7zOISNVhr5WX1yWf8iKQni0kE9-5wBcoiokZs2Ueg/edit>. Accessed August 7, 2019.
  23. Jamieson S. Likert scales: how to (ab)use them. *Med Educ*. 2004;38(12):1217-1218. <https://doi.org/10.1111/j.1365-2929.2004.02012.x>.
  24. IBM Corp. Released. *IBM SPSS Statistics, Version 22.0*. Armonk, NY: IBM Corp.; 2013.
  25. Regber S, Novak M, Eiben G, et al. Parental perceptions of and concerns about child's body weight in eight European countries - the IDEFICS study. *Pediatr Obes*. 2013;8(2):118-129. <https://doi.org/10.1111/j.2047-6310.2012.00093.x>.
  26. McPherson AC, Hamilton J, Kingsnorth S, et al. Communicating with children and families about obesity and weight-related topics: a scoping review of best practices. *Obes Rev*. 2017;18(2):164-182. <https://doi.org/10.1111/obr.12485>.
  27. Lupi JL, Haddad MB, Gazmararian JA, Rask KJ. Parental perceptions of family and pediatrician roles in childhood weight management. *J Pediatr*. 2014;165(1):99-103.e2. <https://doi.org/10.1016/J.JPEDI.2014.02.064>.
  28. Isma GE, Bramhagen A-C, Ahlstrom G, Östman M, Dykes A-K. Obstacles to the prevention of overweight and obesity in the context of child health care in Sweden. *BMC Fam Pract*. 2013;14(1):143. <https://doi.org/10.1186/1471-2296-14-143>.
  29. Sedgwick P. Sources of bias in randomised controlled trials. *BMJ*. 2010;341(dec08 2):c6995-c6995. <https://doi.org/10.1136/bmj.c6995>.
  30. Styne DM, Arslanian SA, Connor EL, et al. Pediatric obesity-assessment, treatment, and prevention: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab*. 2017;102(3):709-757. <https://doi.org/10.1210/jc.2016-2573>.
  31. Barlow SE, Committee E. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120(Suppl 4):S164-S192. <https://doi.org/10.1542/peds.2007-2329C>.
  32. NICE National Institute for Health and Care Excellence. (2015). Obesity in children and young people: prevention and lifestyle weight management programmes. Retrieved from [www.nice.org.uk/guidance/qs94](http://www.nice.org.uk/guidance/qs94)
  33. Ames H, Mosdøl A, Blaasvær N, Nøkleby H, Berg RC, Langøien LJ. Communication of children's weight status: what is effective and what are the children's and parents' experiences and preferences? A mixed methods systematic review. *BMC Public Health*. 2020;20:574.

## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Tommerup K, Smith AD, Evans EH, et al. The acceptability and feasibility of using a 3D body size scale to initiate conversations about weight in toddlerhood: a mixed-methods study. *Pediatric Obesity*. 2020;e12715. <https://doi.org/10.1111/ijpo.12715>