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Using a thin slice coding approach to assess preschool overweight and obesity

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Abstract
Obesity is a major public health problem and cause of significant burden across the lifespan. Longitudinal samples, beginning in early childhood offer an advantageous approach to studying obesity, given the potential to observe within-individual changes over time. Yet among the many available longitudinal studies of children, particularly those studying psychological disorders, do not assess for overweight/obesity status or related constructs necessary to compute BMI. We offer a unique thin slice approach for assessing obesity/overweight status using previously collected video data. The current study observationally coded overweight/obesity status in a clinically enriched sample of preschoolers oversampled for depression ($N = 299$). Preschoolers (ages 3–6 years) completed 1–8 structured observational tasks with an experimenter. Overweight/obesity was coded using a "thin slice" technique with 7820 unique ratings available for analysis. Parent-reported physical health problems were assessed throughout the study and BMI percentiles were available from ages 8–19 years. Thin-slice ratings of overweight/obesity were reliably observed in preschoolers' ages 3–6 years. Thin-slice ratings of overweight/obesity during preschool significantly predicted adolescent BMI percentiles at six separate assessments spanning ages 8–19 years. Further, preschool overweight/obese thin-slice ratings were associated with more physical health problems over time and less sport/activity participation during preschool. Overweight/obesity can be observationally identified in preschool-age children and offers a reliable estimate of future BMI percentile. Study findings highlight how previously collected data could be utilized to study the developmental trajectories of overweight/obesity to inform this critical public health problem.

Keywords Thin-slice coding · Obesity · Overweight · Preschool · Secondary data analysis · Observational coding

Highlights

- We offer a unique method for leveraging existing observational data to assess childhood overweight/obesity, the costliest and most impairing public health issue of our time.
- A thin slice coding technique examined whether overweight/obese status can be reliably identified in observations of preschoolers by unacquainted observers.
- Overweight/obesity can be observationally identified in preschool-age children and offers a reliable estimate of future BMI percentile.

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Introduction

Despite the belief that young children are naturally physically active, close to 30% of U.S. preschoolers are overweight or obese (Ogden et al., 2016), including an upward trend toward more severe forms of obesity (Skinner & Skelton, 2014). Efforts to reduce obesity across development have been largely ineffective, leading to recent calls for the implementation of a developmental psychopathology approach that studies children across time (Bohnert et al., 2020; Russell & Russell, 2019).

Collecting this type of longitudinal data across development is resource intensive, requiring large cohorts and transdisciplinary expertise. While many longitudinal studies of developmental processes exist (Davis-Kean et al., 2015), most do not contain repeated assessments of height, weight, and/or other metrics needed to determine BMI percentiles, overweight/obesity, and weight changes. However, many of these intensive longitudinal developmental studies do include hundreds of videos of children engaged in different tasks, interactions, interviews, and other research protocols related to the primary research questions. Importantly, many developmental studies systematically assess known risk factors including temperament, emotional functioning, parenting practices, and family environments. This information could be utilized and combined with existing observational data to examine a variety of processes leading to increased obesity risk or highlighting pathways of resilience from early overweight/obesity. Thus, we offer a unique method for leveraging existing observational data to address the costliest and most impairing public health issue of our time. The current study used a thin slice coding technique to examine whether overweight/obese status can be reliably identified in observations of preschoolers by unacquainted observers.

Overweight/Obesity in Preschoolers

Children with obesity have a fivefold increased risk of obesity in adulthood (Simmonds et al., 2016) and 60% higher health care costs compared to children who are healthy weight (Hayes et al., 2016). Establishing trajectories of normative and non-normative patterns in weight gain and weight-related behaviors and their implications for obesity risk are crucial to disease prevention and health promotion.

Typically, overweight/obese status is measured by calculating body mass index (BMI) percentiles that are adjusted for age and sex. The calculation, while simple, requires height and weight to be objectively measured during an in-person visit or assessment. Studies designed to assess health, obesity, and related outcomes in children collect this data from participants, but many developmental psychopathology studies do not or did not include these metrics in data collection efforts. This opens an exciting and untapped opportunity to use existing observational data to investigate the role of obesity-risk traits and behaviors such as breastfeeding, sleep, physical health problems, environmental stressors, temperament, and parenting, on the developmental trajectories of overweight/obesity. No previous study has utilized a thin slice coding technique to assess overweight/obesity for secondary data analysis.

Thin Slice Assessment

Naïve observers who have never met an individual can provide accurate ratings in a number of unique domains based on brief periods of observed behavior or still images (Ambady & Rosenthal, 1992; Borkenau et al., 2004; Murphy et al., 2015, 2019; Slepian et al., 2014). These observers reach consensus and make accurate judgements about characteristics as diverse as personality (Borkenau et al., 2004), scientific achievements (Kaczmarek et al., 2017) and socioeconomic status (Kraus et al., 2019; Kraus & Keltner, 2009). Short, "thin-slice" assessments involve naïve observers who view approximately 30-s to one-minute videos of a person in different contexts. Findings with adult samples highlight the ability of an untrained individual, blind to other non-observable subject characteristics, to quickly and accurately assess and classify information relevant to several domains of functioning.

Thin slice approaches have recently been incorporated into ratings of childhood and early adolescent personality traits (Gilbert et al., 2019; 2020; Prime et al., 2014; Tackett et al., 2016, 2017, 2019; Whalen et al., 2020), offering initial evidence of validity and high cost-efficiency to expedite valuable observational coding that is generally resource and time intensive using more standard micro-analytic approaches. In each of these studies, children's personality dimensions were reliability rated by unacquainted observers who watched brief behavioral observations of each child. So far, this method has only been applied to personality ratings in children and it is unclear whether thin slice observational ratings can adequately assess other dimensions, such as health and overweight/obese status. It is important to investigate whether naïve observers can consistently and reliably rate a young child's overweight/obese status based solely on observation across unique situations as the availability of such methods will enhance the potential for secondary data analysis across longitudinal studies that may not have been originally designed to capture this information.

The current study used a thin slice coding technique to assess overweight/obesity in a large heterogeneous preschool sample enriched for clinical psychopathology. The main objectives were to: (1) investigate whether overweight/obese status could be reliably identified in preschoolers using the thin slice method; (2) determine whether thin slice overweight/obesity ratings predicted late childhood and adolescent BMI percentiles as initial validation; and (3) to further inform validity, examine whether preschool thin slice overweight/obese ratings were associated with breastfeeding history, physical health across time, and preschool sports/activity participation. Specifically, given the subjective nature of this coding approach, we sought to establish external validity by associating the codes with well-established correlates of childhood obesity: (lack of) breastfeeding (Uwaezuoke et al., 2017; Wang et al., 2017), indicators of poor physical health (Kumar & Kelly, 2017; Pulgarón, 2013), and low sport/activity participation (Nelson et al., 2011). Establishing the reliability of this highly feasible method may be one critical step towards bettering our understanding of the developmental pathways leading to overweight/obesity as this data could be harnessed and combined from many longitudinal studies not primarily designed to assess health.

Methods

Participants

Participants included 305 young children enrolled in the Preschool Depression Study (Luby et al., 2009a). The Preschool Depression Study study is a prospective longitudinal study of preschool-age children designed to investigate the validation and longitudinal course of preschool depression, conducted at the Washington University School of Medicine. For the study, 3.0- to 5.92 year-old children and their primary caregivers were recruited from daycares, preschools, and primary care sites, using the Preschool Feelings Checklist (Luby et al., 2004) to oversample children with depression or at-risk for depression. Healthy preschoolers and those with other psychiatric disorders were also included in the study via similar recruitment methods. Children have since undergone annual diagnostic and developmental assessments (i.e., approximately every 12 months). Parental consent and child verbal assent were obtained before study participation. The Institutional Review Board approved all procedures in accordance with institutional ethical guidelines.

Procedures

As part of the larger study, trained staff conducted annual in-person diagnostic assessments with primary caregivers beginning at study enrollment (Luby et al., 2009b). Approximately 65% (*n* = 197) of these children were diagnosed with a psychiatric disorder during the preschool period (ages 3–6 years). During the preschool period, children were also videotaped while completing several tasks from the LABTAB assessment battery (Goldsmith et al., 1999) (see Table 1 for list and description of tasks). For the current report, 8–18 unique observers rated each child's overweight/obese status using this previously recorded video during each of the LABTAB tasks conducted as part of the larger project.

Measures

Overweight/Obese Status To obtain the best approximation of preschool overweight/obese status, observational data was coded using a thin slice technique and aggregated from the first three annual assessments (representing the preschool-age period). Thus, 7820 unique ratings of children during ages 3–6 years formed the basis for the thin slice assessments by unacquainted observers. The unacquainted observers were 27 undergraduate research assistants and Bachelors/Masters-level staff of the Early Emotional Development Program. Observers varied in terms of education level, race, ethnicity, gender, and age. Each observer was oriented to the thin slice protocol and then completed his/her ratings of each child. The orientation session lasted approximately 30 min, briefly described the thin slice procedure, and reviewed each rating that was to be made (Whalen et al., 2020). Observer's remained blind to non-observable, child diagnostic and social characteristics (e.g., income to needs) that may have unintentionally influenced ratings. At least 8 and up to 18 unique observers rated whether they believed each child was overweight or obese (dichotomous, yes/no rating) during each of the observational tasks conducted as part of the larger study. These tasks included a standard set of instructions given by a research assistant, who interacted with the child apart from his/her caregiver.

In order to make overweight/obese ratings, each observer watched approximately 60-s (taken from the middle) of each structured observational task as done in prior work using the thin slice technique (Carney et al., 2007; Hirschmann et al., 2018; Murphy et al., 2015; Whalen et al., 2020). Each video was coded for: (1) an overweight/obese dichotomous rating and (2) Big Five (extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience) personality dimensions (Whalen et al., 2020). Ratings were averaged across observers with an average of 25.7 (SD = 5.13; Min = 10, Max = 33) unique ratings included for each child. Six children with less than 10 ratings were excluded, resulting in a final sample of *n* = 299.

Table 1 Thin Slice Observational Tasks

Task Name	Description	Temperament Evoked
1. Box Empty	Child given a wrapped gift to unwrap, however the wrapped box was empty	Negative emotionality
2. Impossibly Perfect Circles	Child instructed to draw circles on blank paper, each circle was critiqued and the child asked to draw another circle	Negative emotionality; Persistence
3. Popping Bubbles	Child and experimenter play together with a bubble-making toy	Positive affect; Interest
4. Picture Tearing	Child shown favorite picture of experimenter and then instructed to tear picture by another experimenter	Compliance; Guilt
5. Snack Delay	Child instructed to wait for experimenter to ring bell prior to eating a snack and experimenter delayed	Inhibitory control
6. Storytelling	Child instructed to tell a story about what he/she did yesterday standing in front of two experimenters	Social inhibition; Shyness
7. Transparent Box	Child given a desirable toy inside a locked transparent box and given incorrect ring of keys to open the box	Frustration; Persistence; Interest
8. Tea Cups	Child and experimenter have a tea party and child is given a teacup with a faulty handle	Guilt; Negative emotionality

Late Childhood and Adolescent BMI Percentiles Trained research assistants obtained children's height and weight (measured without shoes) at each behavioral assessment beginning in late childhood using a standardized procedure and calibrated medical scale. BMI was calculated according to the CDC growth charts (Kuczmarski et al., 2002) using the standard formula (weight in kilograms divided by height in meters squared rounded to one decimal place). Age and gender adjusted BMI percentiles were created using the formula and syntax available on the CDC website (*SAS Program (Ages 0 to < 20 Years) | Resources | Growth Chart Training | Nutrition | DNPAO | CDC*, , 2019). BMI percentile data is available from at least one and up to five unique annual assessments for each participant. During these assessments, participants ranged in age from 8 to 19 years.

Income to Needs Mothers reported on the family income between the ages of 3–6 years. The income- to-needs ratio was computed as the total family income at baseline divided by the federal poverty level, based on family size, at the time of data collection (McLoyd, 1998). A score below 1 is indicative of poverty.

Breastfeeding History Information about breastfeeding was obtained during the initial preschool assessment when the child was between the age of 3–6 from the primary caregiver (91% biological mother) using the psychosocial section of the Preschool Age Psychiatric Assessment (Egger et al., 2003, 2006). Dichotomous data about breastfeeding (did you breastfeed your child, yes or no?) was used.

Physical Health Problems Caregivers completed the MacArthur Health and Behavior Questionnaire (Essex et al., 2002) at each assessment. The Global Physical Health subscale was used in the current report as an indicator of physical health problems. This composite score assesses indicators of poor health and difficulties stemming from physical health problems (e.g., missing school) in youth with higher scores indicating worse physical health. Internal consistency of this scale ranged from adequate to good ($\alpha = 0.686–0.778$) across the waves of data collection. We used this composite in two ways: (1) the score from the preschool period was used as a subjective indicator of validity (Table 4); (2) latent classes trajectories were previously constructed (Blinded for peer review) and used as an indicator of predictive validity of the thin slice code over time.

During the preschool period, the MacArthur Health Behavior Questionnaire also asks caregivers to report on whether their child has been diagnosed with specific medical conditions. Given that most of the medical conditions were rule-outs for enrollment in the larger study (e.g., neurological conditions), we selected asthma and severe allergies as potential objective indicators that would be related to overweight/obese status.

Preschool Sports, Activity, and Club Participation The MacArthur Health Behavior Questionnaire (Essex et al., 2002) was also used to assess sport, activity, and club participation during the preschool years. Caregivers were asked whether their child participated in any sports, activities such as dance lessons, and/or clubs such as scouts. The dichotomous answers to these questions were used in analyses.

Statistical Analysis Analyses were conducted to first validate the overweight/obese thin slice coding rating and then to explore whether the rating was associated with objective measures of health including physical health and sports participation and late childhood/adolescent BMI percentiles. Intraclass correlation coefficients (ICCs) were calculated for inter-rater agreement. Independent samples *t*-tests and Chi-Square analyses were used to determine whether there were group differences between the overweight/obesity groups in age, sex, race, family income-to-needs ratio, breastfeeding history, preschool physical health, preschool sports participation, and late childhood/adolescent BMI percentiles.

Participants were classified (Whalen et al., 2016) into subgroups based on physical health problems reported on the MacArthur Health Behavior Questionnaire using growth mixture modeling (GMM). This GMM model estimated unique intercepts and slopes for each class (e.g., within-class variance was freely estimated). Specifically, physical health problem scores were calculated at each annual assessment wave. Quadratic growth mixture models with these scores, as the dependent variables were used to determine categorical latent class variables for grouping participants with similar physical health trajectories. Participants were assigned to the latent class with the greatest probability. A two-class solution was determined to be the best fit: (1) a high, increasing physical health problems latent class and (2) a low, increasing physical health problems latent class. For the current report, class membership was used in a logistic regression analysis to determine whether physical health latent class membership differed by the overweight/obese thin slice code.

We analyzed change in objectively assessed BMI percentile across time (e.g., using all 5 late childhood/adolescent assessment waves) using a multi-level model (MLM) to account for dependency due to repeated measurement. The MLM examined whether preschool overweight/obese status obtained from the thin slice coding predicted the intercept and slope (e.g., the rate of change) in BMI percentile across development. Fixed effects were included for time (e.g., the within individual change over time in BMI percentile across the 5 assessments), preschool overweight/obese thin slice code, and the interaction between time and the preschool overweight/obese code. Covariates included sex and family income-to-needs ratio. Random effects for the BMI percentile intercept and slope for time were included to account for individual variability in mean levels of BMI percentile and rate of change in BMI percentile.

Results

Inter-Rater Agreement

Intraclass correlation coefficients (ICCs) were calculated among raters' scores of overweight/obese status (Table 2). We used the same types of ICCs reported in past work using the thin slice coding technique as a template for the current study (Borkenau et al., 2004; Koo & Li, 2016; Tackett et al., 2016; Blinded for peer review).

Agreement between individual raters who observed the same task (e.g., the ICC using single ratings for a single task) was 0.48. Two random rater's overweight/obesity assessment for a single task would correlate roughly .48, which is greater in magnitude when compared to the agreement levels seen using the thin slice technique for personality dimensions (Connelly & Ones, 2010; Whalen et al., 2020). Given that we had 8–18 unique raters for each child, we also estimated the reliability equivalent to the Chronbach's alpha for *k* raters assessing the same thin slice (e.g., the ICC using the averaged ratings for a single task). Agreement of all the raters who observed the same task (average of 3) was 0.73.

Reliability was also estimated by collapsing across tasks to estimate agreement for an overall overweight/obesity rating (e.g., the ICC using the averaged ratings across tasks). The ICC was similar in magnitude compared to the estimate for a single task, 0.72. This ICC is significantly higher than prior research using the thin slice coding technique to assess children's personality dimensions (Tackett et al., 2016, 2017; Whalen et al., 2020.

Additional ICCs were calculated among raters' scores of overweight/obese status using the same steps above but separately by child sex and race (white vs. minority race; Table 2) in order to determine whether these factors influenced reliability. ICCs were compared using the methods outlined by Feldt and colleagues (Feldt et al., 1987). There were no sex differences in any of the ICCs calculated (e.g., 1,1; 1,3; or 2,1). Agreement between individual raters who observed the same task for males was 0.45 and for females was 0.52 ($F = 1.13$, $p = 0.24$). Agreement of all the raters who observed the same task (average of 3) for males was 0.71 and for females was 0.75 ($F = 1.16$, $p = 0.19$). The ICC using the averaged ratings across tasks (2,1) for males was 0.70 and for females was 0.74 ($F = 1.15$, $p = 0.19$). There were significant race differences in each of the ICCs, with minority race participants being rated more consistently than white participants (Table 2). Agreement between individual raters who observed the same task for white participants was 0.32 and for minority race participants was 0.58 ($F = 1.62$, $p = 0.01$). Agreement of all the raters who observed the same task (average of 3) for white participants was 0.52 and for minority race participants was 0.79 ($F = 2.29$, $p = 0.000$). The ICC using the averaged ratings across tasks (2,1) for white participants was 0.51 and for minority race participants was 0.78 ($F = 2.23$, $p = 0.000$).

Correlates of Overweight/Obesity Ratings during the Preschool Period

To offer further evidence of the validity of the coding, group differences in demographic variables, objective indices of breastfeeding, preschool physical health, physical health latent class, and preschool sports participation as a function of thin-slice ratings of overweight/obesity are reported in Tables 3 and 4. No age, sex, race, or income-to-needs differences were noted by preschool overweight/obese status. Preschoolers coded as overweight/obese based on thin-slice ratings were less likely to have been breastfed as infants ($X^2 = 4.51$, $p = 0.03$). Overweight/obese preschoolers were more likely to have poor physical health ($M = 0.69$, $SD = 0.61$) as reported by their caregivers when compared to preschoolers not coded as overweight/obese ($M = 0.41$, $SD = 0.52$; $t_{296} = -3.86$, $p < 0.000$). Overweight/obese preschoolers were also more likely to have severe allergies ($X^2 = 3.88$, $p = 0.04$) and at trend level, asthma ($X^2 = 3.53$, $p = 0.06$) when compared to preschoolers not coded as overweight/obese. Finally, overweight/obese preschoolers were less likely to participate

Table 2 Intraclass Correlation Coefficients Among Raters of Thin-Slice Overweight/Obesity Code

	Single rater/ single task (1,1)	Average rater/ single task (1.3)	Cross rater/cross task (2, 1)
Overall Sample	.48	.73	.72
By Sex			
Male	.45	.71	.70
Female	.52	.75	.74
By Race			
White	.32	.52	.51
Minority	.58	.79	.78

Table 3 Thin Slice Overweight/Obese Group Differences in Demographics, Physical Health Latent Class, and BMI percentiles

	Thin Slice Not Overweight/Obese (N =224)		Thin Slice Overweight/Obese (N =78)		Comparison	
	Mean/N	*SD%*	Mean/N	*SD%*	t/X^2	*p*
Age	5.47	0.80	5.35	0.78	1.03	.31
Sex (male)	121	53.8	36	46.2	1.35	.25
Race (minority)	98	42.6	42	53.8	2.47	.12
Preschool Income-to-Needs ratio	2.16	1.15	1.88	1.22	1.50	.13
Physical Health Problems Latent Class (High)	30	15.9	27	41.5	18.31	.000
Wave 8 BMI percentile (M_{age} =9.68 years)	57.07	27.72	81.69	23.68	−6.47	.000
Wave 10 BMI percentile (M_{age} =10.68 years)	56.84	27.62	81.86	23.40	−6.36	.000
Wave 12 BMI percentile (M_{age} =11.85 years)	57.58	28.63	83.94	22.69	−5.02	.000
Wave 14 BMI percentile (M_{age} =13.07 years)	59.59	28.44	82.34	19.52	−3.49	.001
Wave 18 BMI percentile (M_{age} =15.93 years)	63.90	26.77	86.56	19.99	−5.18	.000

in sports or other physical activities, such as dance lessons when compared to preschoolers not coded as overweight/obese ($X^2 = 6.23$, $p = 0.01$), however both groups were equally likely to participate in nonphysical clubs such as scouts and church ($X^2 = 0.00$, $p = 0.98$).

Childhood into Adolescence: Global Physical Health Trajectories

A Logistic regression was conducted to determine whether membership in the physical health latent classes differed by the overweight/obese thin slice code. Covariates included age, sex, and income-to-needs ratio. Children in the high, increasing class of physical health problems were 3.42 times more likely to be coded as overweight/obese during the preschool period (B = 1.23, SE = 0.35, Wald = 12.30, $p < .001$) when compared to children in the low, increasing class of physical health problems.

Childhood into Adolescence: BMI Percentile Trajectories

Multi-level models were conducted to determine whether thin slice coding of overweight/obese status in preschool predicted significant increases in BMI percentiles over time (Table 5; Fig. 1). There was a main effect of both time and the preschool overweight/obese thin slice code, indicating an average association with BMI percentile. These main effects were qualified by an interaction between time and the preschool overweight/obese thin slice code in predicting the rate of change in BMI percentile across development (Fig. 1). To aid in the interpretation of this effect, we tested the significance of the slopes for each group. For the overweight/obese group based on preschool thin-slice ratings, the slope was 0.42 ($p = 0.02$) and for the healthy weight preschool group, the slope was 0.15 ($p = 0.76$). Thus, the overweight/obese group evidenced a significant increase in their BMI percentiles across time, whereas

Table 4 Thin Slice Overweight/Obese Group Differences in Breastfeeding, Preschool Physical health, and Preschool Sport/Activity participation

	Thin Slice Not Overweight/Obese (N=224)		Thin Slice Overweight/Obese (N=78)		Comparison	
	Mean/N	*SD%*	Mean/N	*SD%*	t/X^2	*p*
Breastfed (no)	82	36%	40	51%	4.51	.034
Preschool Global Physical Health Problems	0.41	0.52	0.69	0.61	−3.86	.000
Preschool Asthma (yes)	50	22%	24	31%	3.53	0.06
Preschool Allergies (yes)	49	22%	25	33.3%	3.88	0.04
Preschool Sports and Activity Participation (yes)	157	70.4%	41	54.7%	6.23	0.01
Preschool Clubs (yes)	83	37.2%	28	37.3%	0.00	0.98

Table 5 Fixed-effects estimates from the MLM predicting change in BMI percentile from Preschool Overweight/Obese Thin Slice Code

Parameter	Estimate	SE	*df*	*t*	*p*	Lower 95% CI	Upper 95% CI
Intercept	52.06	3.93	470.84	13.26	.000	44.34	59.77
Wave	.51	.18	194.81	2.82	.01	.15	.87
Sex	3.08	3.28	226.28	.94	.35	−3.37	9.53
Income to Needs	.04	1.15	675.24	.04	.97	−2.22	2.31
Thin Slice Overweight/Obese	52.29	9.53	357.02	5.49	.000	33.55	71.03
Wave*Thin Slice	5.51	1.69	179.48	3.24	.001	2.15	8.87

there was no significant increase or decrease in BMI percentiles for the healthy weight group.

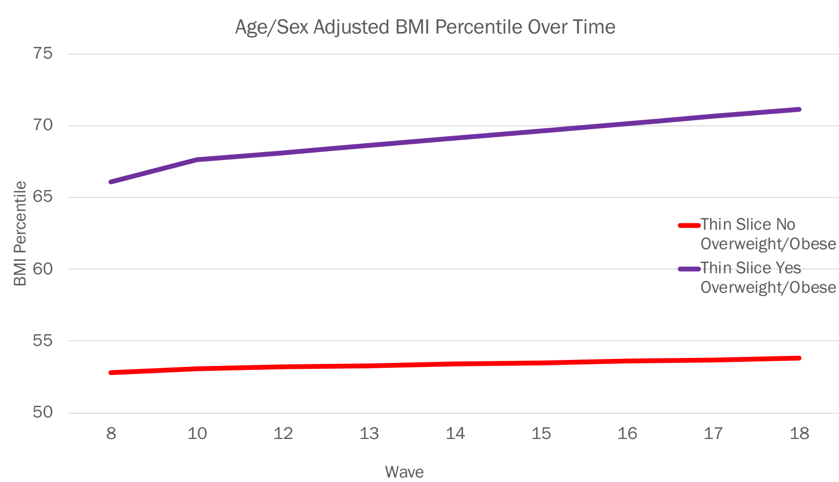
We also wanted to determine if there were specific periods (e.g., assessments) when preschool overweight/obese status was most predictive of late childhood/adolescence BMI percentiles. Overweight/obese preschoolers evidenced higher BMI percentiles at each of the follow-up assessment waves (Table 3), with no difference in the strength of these associations across the waves.

Discussion

The current study demonstrated support for the observational detection of overweight/obesity in the preschool period using a thin slice coding approach on previously collected data. Thin slice ratings of overweight/obesity showed within-task/inter-rater agreement, internal consistency, and cross-rater agreement that was significantly higher than that seen in past work using a thin slice approach to assess other domains, such as personality traits. Overweight/obese status in preschoolers was shown to be reliably observable by a diverse group of unacquainted and untrained raters (i.e., not parents or medical professionals). Although it may seem obvious that this type of physical trait can be accurately observed and correctly identified, we present additional evidence of the external and ecological validity, indicating that this coding identifies children who are at highest risk for developmental trajectories of poor physical health and obesity. The thin slice ratings also predicted rates of change in BMI percentiles across development as well as BMI percentiles assessed at each wave of the study. Further, thin slice overweight/obese ratings were related to known correlates of obesity such as worse physical health, asthma, allergies, and lack of participation in physical activities. These results provide support for the use of the thin slice coding technique as a cost-effective, efficient way to utilize already existing databases to capture constructs that were not originally measured.

These results indicate evidence for agreement across the thin slice raters. We examined the internal consistency across all raters and found that the reliability of averaged ratings was good across all dimensions (average ICC = .73), significantly higher than ratings for other domains, such as personality traits in studies using children/adolescents. Furthermore, agreement of different observers rating different tasks evidenced good consensus (average r = .72). This suggests that independent thin slice ratings show the type of reliability that would be expected if ratings were tapping into a valid observable trait. Additional ICCs determined that race, but not sex, positively influenced reliability, with minority race participants being rated more consistently than white participants. However, regardless of child race or sex, reliabilities were

Fig. 1 Model-implied trajectories of BMI percentiles across time by overweight/obese thin slice group



consistently moderate to high. Given the minimal amount of time needed to train coders (e.g., approximately 30 min), this method represents an efficient way of assessing preschool overweight/obese status, particularly when physical health metrics were not originally collected.

In line with the 6-C's model of childhood overweight and obesity(Harrison et al., 2011) which categorizes environmental influences across several spheres (cell, child, clan, community, country, and culture), we examined history of breastfeeding, preschool physical health, physical health latent class membership, and preschool sports participation as a function of thin-slice ratings of overweight/obesity. Preschoolers coded as overweight/obese based on thin-slice ratings were less likely to have been breastfed as infants, more likely to have poor physical health, more likely to have severe allergies and at trend level, asthma, and less likely to participate in sports or other physical activities when compared to preschoolers not coded as overweight/obese. Most striking was that children coded as overweight/obese during preschool were 3.42 times more likely to be in a latent class of high, increasing physical health problems, capturing their development from preschool through adolescence. Taken together, these results suggest that the overweight/obese thin slice code appears to accurately reflect children's physical health and functioning and is associated with well-validated risk factors for overweight/obesity.

We also investigated whether the thin slice overweight/obese rating was related to objectively measured BMI percentiles across childhood and into adolescence. At each assessment wave occurring during late childhood and adolescence (ages 8–19 years), the observed preschool thin slice code was strongly associated with objectively assessed BMI percentile. These findings were not surprising as a recent meta-analysis found that children with obesity are at a fivefold increased risk of obesity in adulthood(Simmonds et al., 2016). Multilevel models indicated that not only were thin slice ratings predictive of BMI percentiles, they were also predictive of an increase in BMI percentiles across development (e.g., a steeper slope). The preschool thin slice code accurately classified those at the highest risk for overweight/obesity throughout development. Given recent calls to incorporate developmental psychopathology perspectives into childhood obesity research (Bohnert et al., 2020; Russell & Russell, 2019), this finding and approach represent an important first step in utilizing the rich body of available pre-existing datasets to examine these critical questions.

Limitations of the current study should be noted. First, 197 (65%) of preschoolers had psychiatric disorders at baseline and the sample was enriched specifically for preschool depressive disorders. Therefore, it will be important to replicate these findings in a community-based sample to ensure that the reliability and validity of our overweight/obese code are not due to the nature of the sample. Further, we do not have information on parental weight status, a well-known and validated risk factor for childhood overweight/obesity. This information would be useful in enhancing the validity of the code. The current study also has merit in the use of a rich, longitudinal dataset not originally designed to assess physical health. This type of coding is not meant to replace objective measures, such as BMI percentiles but to be used as a supplement to these types of objective measures in order to expand the research questions that can be addressed and integrate data across multiple study samples. In doing so, researchers can address high impact questions regarding the development and maintenance of overweight/obesity that are often overlooked and may be prohibitively expensive and/or time-consuming to answer using newly collected data.

Conclusions

The current study used a large sample of clinically enriched preschoolers with observational data across a series of laboratory tasks in order to determine whether overweight/obesity could be reliably identified. Findings illustrate that overweight/obesity can be reliably observed using the thin slice technique in children as young as preschool. This technique has the advantage of being highly feasible in that naive raters can be trained to reliability in a short amount of time and coding can be completed quickly. Thin slice ratings demonstrated encouraging psychometric properties including within-task inter-rater agreement and strong correlations with objectively observed BMI percentiles across development. Further, the observed preschool ratings predicted increases in BMI percentiles from late childhood through adolescence as well as high, increasing physical health problems over time. Additional research is needed to further test the reliability and validity of this approach during other developmental periods and with larger samples.

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Data Availability Data available on request due to privacy/ethical reasons.

Declarations

Conflict of Interest The authors have no conflicts of interest to disclose.

References

Ambady, N., & Rosenthal, R. (1992). Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin, 111*(2), 256–274. https://insights.ovid.com/psychological-bulletin/plbul/1992/03/000/thin-slices-expressive-behavior-predictors/3/00006823.

Bohnert, A. M., Loren, D. M., & Miller, A. L. (2020). Examining childhood obesity through the lens of developmental psychopathology: Framing the issues to guide best practices in research and intervention. *American Psychologist, 75*(2), 163–177. https://doi.org/10.1037/amp0000581.

Borkenau, P., Mauer, N., Riemann, R., Spinath, F. M., & Angleitner, A. (2004). Thin slices of behavior as cues of personality and intelligence. *Journal of Personality and Social Psychology, 86*(4), 599–614. https://doi.org/10.1037/0022-3514.86.4.599.

Carney, D. R., Colvin, C. R., & Hall, J. A. (2007). A thin slice perspective on the accuracy of first impressions. *Journal of Research in Personality, 41*(5), 1054–1072. https://doi.org/10.1016/j.jrp.2007.01.004.

Connelly, B. S., & Ones, D. S. (2010). An other perspective on personality: Meta-analytic integration of observers' accuracy and predictive validity. *Psychological Bulletin, 136*(6), 1092–1122.

Davis-Kean, P. E., Jager, J., & Maslowsky, J. (2015). Answering developmental questions using secondary data. *Child Development Perspectives, 9*(4), 256–261. https://doi.org/10.1111/cdep.12151.

Egger, H. L., Ascher, B., & Angold, A. (2003). The preschool age psychiatric assessment: Version 1.4. Center for Developmental Epidemiology, Department of Psychiatry and Behavioral Sciences. Duke University Medical Center, Durham, NC.

Egger, H. L., Erkanli, A., Keeler, G., Potts, E., Waltr, B. K., & Angold, A. (2006). Test-retest reliability of the preschool age psychiatric assessment (PAPA). *Journal of the American Academy of Child & Adolescent Psychiatry, 45*(5), 538–549. https://doi.org/10.1097/01.chi.0000205705.71194.b8.

Essex, M. J., Boyce, W. T., Goldstein, L., Armstrong, J., Kraemer, H. C., & Kupfer, D. J. (2002). The confluence of mental, physical, social, and academic difficulties in middle childhood. II: Developing the MacArthur Health and Behavior Questionnaire. *Journal of the American Academy of Child & Adolescent Psychiatry*, 41(5), 588–603. https://doi.org/10.1097/00004583-200205000-00017.

Feldt, L. S., Woodruff, D. J., & Salih, F. A. (1987). Statistical inference for coefficient alpha. Applied Psychological Measurement, 11(1), 93–103.

Gilbert, K. E., Whalen, D. J., Jackson, J. J., Tillman, R., Barch, D. M., & Luby, J. L. (2020). Thin slice derived personality types predict longitudinal symptom trajectories. Personality Disorders: Theory, Research, Treatment. https://doi.org/10.1037/per0000455

Gilbert, K. E., Whalen, D. J., Tillman, R., Barch, D. M., Luby, J. L., & Jackson, J. J. (2019). Observed personality in preschool: Associations with current and longitudinal symptoms. *Journal of Abnormal Child Psychology, 47*(12), 1875–1888. https://doi.org/10.1007/s10802-019-00567-w.

Goldsmith, H., Reilly, J., Lemery, K., Longley, S., & Prescott, A. (1999). Laboratory temperament assessment battery: Preschool version (version 1.0, technical report). *Department of Psychology, University of Wisconsin, Madison, WI.*

Harrison, K., Bost, K. K., McBride, B. A., Donovan, S. M., Grigsby-Toussaint, D. S., Kim, J., Liechty, J. M., Wiley, A., Teran-Garcia, M., & Jacobsohn, G. C. (2011). Toward a developmental conceptualization of contributors to overweight and obesity in childhood: The six-Cs model. *Child Development Perspectives, 5*(1), 50–58. https://doi.org/10.1111/j.1750-8606.2010.00150.x.

Hayes, A., Chevalier, A., D'Souza, M., Baur, L., Wen, L. M., & Simpson, J. (2016). Early childhood obesity: Association with healthcare expenditure in Australia. *Obesity, 24*(8), 1752–1758.

Hirschmann, N., Kastner-Koller, U., Deimann, P., Schmelzer, M., & Pietschnig, J. (2018). Reliable and valid coding of thin slices of video footage: Applicability to the assessment of mother-child interactions. *Journal of Psychopathology and Behavioral Assessment, 40*(2), 249–258. https://doi.org/10.1007/s10862-017-9630-x.

Kaczmarek, L. D., Behnke, M., Kashdan, T. B., Kusiak, A., Marzec, K., Mistrzak, M., & Włodarczyk, M. (2017). Smile intensity in social networking profile photographs is related to greater scientific achievements. *The Journal of Positive Psychology, 0*(0), 1–5. https://doi.org/10.1080/17439760.2017.1326519.

Koo, T. K., & Li, M. Y. (2016). A guideline of selecting and reporting Intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine, 15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012.

Kraus, M. W., & Keltner, D. (2009). Signs of socioeconomic status: A thin-slicing approach. *Psychological Science, 20*(1), 99–106. https://doi.org/10.1111/j.1467-9280.2008.02251.x.

Kraus, M. W., Torrez, B., Park, J. W., & Ghayebi, F. (2019). Evidence for the reproduction of social class in brief speech. *Proceedings of the National Academy of Sciences, 116*(46), 22998–23003. https://doi.org/10.1073/pnas.1900500116.

Kuczmarski, R. J., Ogden, C. L., Guo, S. S., Grummer-Strawn, L. M., Flegal, K. M., Mei, Z., Wei, R., Curtin, L. R., Roche, A. F., & Johnson, C. L. (2002). 2000 CDC growth charts for the United States: Methods and development. *Vital and Health Statistics. Series 11. Data from the National Health Survey, 246*, 1–190.

Kumar, S., & Kelly, A. S. (2017). Review of childhood obesity: From epidemiology, etiology, and comorbidities to clinical assessment and treatment. *Mayo Clinic Proceedings, 92*(2), 251–265. https://doi.org/10.1016/j.mayocp.2016.09.017.

Luby, J. L., Belden, A. C., Pautsch, J., Si, X., & Spitznagel, E. (2009a). The clinical significance of preschool depression: Impairment in functioning and clinical markers of the disorder. *Journal of Affective Disorders, 112*(1–3), 111–119. https://doi.org/10.1016/j.jad.2008.03.026.

Luby, J. L., Heffelfinger, A., Koenig-McNaught, A. L., Brown, K., & Spitznagel, E. (2004). The preschool feelings checklist: A brief and sensitive screening measure for depression in young children. *Journal of the American Academy of Child & Adolescent Psychiatry, 43*(6), 708–717. https://doi.org/10.1097/01.chi.0000121066.29744.08.

Luby, J. L., Si, X., Belden, A. C., Tandon, M., & Spitznagel, E. (2009b). Preschool depression: Homotypic continuity and course over 24 months. *Archives of General Psychiatry, 66*(8), 897–905. https://doi.org/10.1001/archgenpsychiatry.2009.97.

McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist, 53*(2), 185–204. https://doi.org/10.1037/0003-066X.53.2.185.

Murphy, N. A., Hall, J. A., Ruben, M. A., Frauendorfer, D., Schmid Mast, M., Johnson, K. E., & Nguyen, L. (2019). Predictive validity of thin-slice nonverbal behavior from social interactions. *Personality and Social Psychology Bulletin, 45*(7), 983–993. https://doi.org/10.1177/0146167218802834.

Murphy, N. A., Hall, J. A., Schmid Mast, M., Ruben, M. A., Frauendorfer, D., Blanch-Hartigan, D., Roter, D. L., & Nguyen, L. (2015). Reliability and validity of nonverbal thin slices in social interactions. *Personality and Social Psychology Bulletin, 41*(2), 199–213. https://doi.org/10.1177/0146167214559902.

Nelson, T. F., Stovitz, S. D., Thomas, M., LaVoi, N. M., Bauer, K. W., & Neumark-Sztainer, D. (2011). Do youth sports prevent pediatric obesity? A systematic review and commentary. *Current Sports Medicine Reports, 10*(6), 360–370. https://doi.org/10.1249/JSR.0b013e318237bf74.

Ogden, C. L., Carroll, M. D., Lawman, H. G., et al. (2016). Trends in obesity prevalence among children and adolescents in the United States, 1988-1994 through 2013-2014. *JAMA, 315*(21), 2292–2299. https://doi.org/10.1001/jama.2016.6361.

Prime, H., Perlman, M., Tackett, J. L., & Jenkins, J. M. (2014). Cognitive sensitivity in sibling interactions: Development of the construct and comparison of two coding methodologies. *Early Education and Development, 25*(2), 240–258. https://doi.org/10.1080/10409289.2013.821313.

Pulgarón, E. R. (2013). Childhood obesity: A review of increased risk for physical and psychological comorbidities. *Clinical Therapeutics, 35*(1), A18–A32. https://doi.org/10.1016/j.clinthera.2012.12.014.

Russell, C. G., & Russell, A. (2019). A biopsychosocial approach to processes and pathways in the development of overweight and obesity in childhood: Insights from developmental theory and research. *Obesity Reviews, 20*(5), 725–749. https://doi.org/10.1111/obr.12838.

SAS Program (ages 0 to < 20 years) | Resources | Growth Chart Training | Nutrition | DNPAO | CDC. (2019, February 26). https://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm

Simmonds, M., Llewellyn, A., Owen, C. G., & Woolacott, N. (2016). Predicting adult obesity from childhood obesity: A systematic review and meta-analysis. *Obesity Reviews, 17*(2), 95–107. https://doi.org/10.1111/obr.12334.

Skinner, A. C., & Skelton, J. A. (2014). Prevalence and trends in obesity and severe obesity among children in the United States, 1999-2012. *JAMA Pediatrics, 168*(6), 561–566. https://doi.org/10.1001/jamapediatrics.2014.21.

Slepian, M. L., Bogart, K. R., & Ambady, N. (2014). Thin-slice judgments in the clinical context. *Annual Review of Clinical Psychology, 10*(1), 131–153. https://doi.org/10.1146/annurev-clinpsy-090413-123522.

Tackett, J. L., Herzhoff, K., Kushner, S. C., & Rule, N. (2016). Thin slices of child personality: Perceptual, situational, and behavioral contributions. *Journal of Personality and Social Psychology, 110*(1), 150–166. https://doi.org/10.1037/pspp0000044.

Tackett, J. L., Lang, J. W. B., Markon, K. E., & Herzhoff, K. (2019). A correlated traits, correlated methods model for thin-slice child personality assessment. *Psychological Assessment, 31*(4), 545–556. https://doi.org/10.1037/pas0000635.

Tackett, J. L., Smack, A. J., Herzhoff, K., Reardon, K. W., Daoud, S., & Granic, I. (2017). Measuring child personality when child personality was not measured: Application of a thin-slice approach. *Personality and Mental Health, 11*(1), 4–13. https://doi.org/10.1002/pmh.1351.

Uwaezuoke, S. N., Eneh, C. I., & Ndu, I. K. (2017). Relationship between exclusive breastfeeding and lower risk of childhood obesity: A narrative review of published evidence. *Clinical Medicine Insights: Pediatrics, 11*, 1179556517690196. https://doi.org/10.1177/1179556517690196.

Wang, L., Collins, C., Ratliff, M., Xie, B., & Wang, Y. (2017). Breastfeeding reduces childhood obesity risks. *Childhood Obesity, 13*(3), 197–204. https://doi.org/10.1089/chi.2016.0210.

Whalen, D. J., Belden, A. C., Tillman, R., Barch, D. M., & Luby, J. L. (2016). Early adversity, Psychopathology, and Latent Class Profiles of Global Physical Health From Preschool Through Early Adolescence. *Psychosomatic Medicine, 1*, 1008–1018. https://doi.org/10.1097/PSY.0000000000000398.

Whalen, D. J., Gilbert, K. E., Jackson, J. J., Barch, D. M., & Luby, J. L. (2020). Using a thin slice coding approach to assess preschool personality dimensions. *Journal of Personality Assessment, 0*(0), 1–10. https://doi.org/10.1080/00223891.2020.1722140.