



UNIVERSITY OF LEEDS

This is a repository copy of *Investigation of psychometric properties of the Mindful Eating Questionnaire in Chinese adolescents and young adults using mixed methods*.

White Rose Research Online URL for this paper:

<https://eprints.whiterose.ac.uk/188472/>

Version: Accepted Version

Article:

Zhang, Q, Hugh-Jones, S orcid.org/0000-0002-5307-1203 and O'Connor, DB orcid.org/0000-0003-4117-4093 (2022) Investigation of psychometric properties of the Mindful Eating Questionnaire in Chinese adolescents and young adults using mixed methods. *Appetite*, 176. 106097. ISSN 0195-6663

<https://doi.org/10.1016/j.appet.2022.106097>

© 2022 Elsevier Ltd. All rights reserved. This manuscript version is made available under the CC-BY-NC-ND 4.0 license <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

Reuse

This article is distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND) licence. This licence only allows you to download this work and share it with others as long as you credit the authors, but you can't change the article in any way or use it commercially. More information and the full terms of the licence here: <https://creativecommons.org/licenses/>

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.



eprints@whiterose.ac.uk
<https://eprints.whiterose.ac.uk/>

Psychometric properties of the MEQ in Chinese samples

**Investigation of psychometric properties of the Mindful Eating Questionnaire in
Chinese adolescents and young adults using mixed methods**

In press

Appetite

Qian Zhang, Siobhan Hugh-Jones & Daryl B.O'Connor

School of Psychology

University of Leeds, UK

ABSTRACT

Overweight and obesity are major public health challenges in China, and increasingly among young people. Valid measures are needed to examine the relationship between eating styles and weight to advance understanding and intervention. Mindful approaches show promise in weight management. This study aimed to investigate the psychometric properties of a Chinese version of Mindful Eating Questionnaire (C-MEQ). Study 1 used a think aloud methodology to examine Chinese young adults' ($n = 7$) and adolescents' ($n = 10$) comprehension of C-MEQ items. Findings informed revision of problematic items before a full validation study (Study 2) of the revised C-MEQ (C-MEQ-R) in a sample of 430 Chinese young adults. In Study 1, both groups misinterpreted ten items as asking about noticing about whether behaviour ever occurred rather than noticing experience, indicating the lack of content validity of the C-MEQ. Ten items were rephrased to emphasise mindful (intentional) noticing in the moment. In Study 2, confirmatory factor analysis revealed an inadequate fit to the original MEQ structure. Exploratory Structural Equation Model of the C-MEQ-R revealed five distinct domains. The C-MEQ-R showed better psychometric properties than the C-MEQ, and significant associations with mindfulness, emotional eating, external eating and BMI in expected directions. However, psychometric limitations including low internal reliability, inadequate coherence of the subscales and limited construct validity were identified. These findings contribute to the progress in the measurement of mindful eating by highlighting the weaknesses of the MEQ. Further research is called to adopt and validate alternative mindful eating measurements to assess mindful eating in Chinese adolescents and young adults.

1. Introduction

Obesity is a worldwide public health concern which can cause a series of physiological and psychosocial problems (Williams et al., 2015). In the last three decades, with the rapid and ongoing urbanization, China has seen a substantial increase in the prevalence of overweight and obesity (Wang et al., 2020). Data from the National Health Service Surveys (NHSSs) of China showed that in 2018, the standardized prevalence of overweight and obesity was 15.8% in children and adolescents, and 25.6% in adults (Wang et al., 2020). Effective interventions and policies are urgently needed to tackle this public-health challenge. Particularly, recent population-based studies suggested that adolescents and young adults should be the priority target of such interventions (Chen et al., 2019; Guo et al., 2019; Wang et al., 2020; Zhang et al., 2018). For example, Zhang et al. (2018) found that the overweight prevalence from 2011 to 2015 had stabilized in children but still been increasing among adolescents. Wang et al. (2020) reported an especially sharp increase in the overweight / obesity prevalence of Chinese young adults aged 19 to 29 years from 2013 to 2018. Therefore, it is essential to find scalable public health approaches to obesity prevention and treatment for Chinese adolescents and young adults.

Mindfulness-based interventions (MBIs), tailored towards eating practices (E-MBIs), aim to help people eat well and manage their weight. Evidence for the effectiveness of E-MBIs on weight management is growing, with moderate to large effects in reducing binge eating, emotional eating and external eating, and mixed but promising evidence for their effectiveness on weight loss (Carrière et al., 2018; Dunn et al., 2018; O'Reilly et al., 2014; Warren et al., 2017). Becoming a more mindful eater is the proposed mediator of these outcomes (Dunn et al., 2018).

E-MBIs teach the principles and skills of mindfulness to help people become more aware, and less automatic, in their eating environments, choices and experiences, and to do so with a non-judgmental, enquiring attitude about eating drivers and choices (Dunn et al., 2018). E-MBIs propose that developing awareness of, and non-critical attitude towards,

eating generates new insights which can trigger change (Warren et al., 2017). The three proposed essential elements of mindful eating are: noticing the characteristics of food including its taste, smells, and textures; recognising one's eating habits and patterns; and being aware of the triggers for, and sensations around, initiating and stopping eating (Albers, 2009).

Valid measures of mindful eating are needed to examine the relationships between ways of eating and health / weight status, as well as for testing E-MBI outcomes and mediators. Five measures of mindful eating exist - the Mindful Eating Scale (Hulbert-Williams et al., 2014), the Mindful Eating Behaviour Scale (Winkens et al., 2018), the newly developed Mindful Eating Inventory (Peitz, Schulze, & Warschburger, 2021) and Four Facet Mindful Eating Scale (Carrière et al., 2022), and the Mindful Eating Questionnaire (MEQ, Framson et al., 2009). The term 'intuitive eating' has been used interchangeably with mindful eating and the Intuitive Eating Scale (IES; Tylka, 2006) has been used as an alternative measure of mindful eating (Warren et al., 2017). The MEQ is the most commonly used measure, and has been culturally adopted and validated in different languages including Italian (Clementi et al., 2017), Iranian (Abbaspoor et al., 2018), Hungarian (Román & Urbán, 2019) and Malay (Basir et al., 2021). However, the MEQ has been validated almost exclusively with adult populations, and a number of problems have been reported with it. As part of our broader work exploring E-MBIs with Chinese young people with overweight/obesity, we wanted to examine the suitability of the MEQ for this population.

The Mindful Eating Questionnaire

The MEQ (Framson et al., 2009) is a 28-item measure that measures five constructs: (i) *disinhibition*, describing one's inability to stop eating when full; (ii) *awareness*, describing the extent to which an individual notices the characteristics of the food they are eating, and the effects of the food on their internal state; (iii) *awareness related to external cues*, indicating one's awareness of external triggers for eating; (iv) *emotional response*, referring to eating in response to negative emotions; and (v) *distraction*, describing a lack of focus on

Psychometric properties of the MEQ in Chinese samples

eating experience while eating. The MEQ was originally validated in a sample of 303 adults (mean age = 42.0 years, $SD = 14.4$) in the United States. Acceptable internal consistency was demonstrated for each subscale (*disinhibition*, 0.83; *awareness*, 0.74; *external cues*, 0.70; *emotional response*, 0.71) except for the *distraction* subscale (0.64). Internal consistency for the MEQ summary score was however questionable (0.64). In addition, the questionnaire included results that cannot be theoretically justified, such as the inclusion of item 13 (“I snack without noticing that I am eating”) to the *emotional response* subscale. Significant negative associations between BMI and the summary MEQ score and all subscales were also reported. However, the original validation sample was likely to have been unrepresentative of a general population, given that a high percentage were recruited from yoga studios (where mindfulness was emphasised), fitness facilities and weight loss programmes.

The MEQ has been employed in intervention studies to explore potential mechanisms of change (e.g., Dibb-Smith et al., 2019), and in cross-sectional studies to investigate its relationship with behavioural, physical or psychological outcomes (e.g., Tronieri et al., 2020). Some of these studies reported acceptable or good internal consistency of the MEQ summary score, with Cronbach’s α ranging from 0.72 to 0.83 (Beshara et al., 2013, Dibb-Smith et al., 2019; Mason et al., 2016; Martin et al., 2013; Moor et al., 2013; Tronieri et al., 2020). However, unsatisfactory internal reliability (Cronbach’s α lower than 0.70) was also frequently reported for the MEQ (Anderson et al., 2016; Apolzan et al., 2016; Goodwin et al., 2017) or for its subscales, particularly *distraction* and *external cues* (Apolzan et al., 2016; Beshara et al., 2013; Dibb-Smith et al., 2019; Mason et al., 2016).

Concerns have also been raised on the construct validity of the MEQ. For example, it has been argued that the MEQ included processes that are beyond the scope of mindfulness while omitting its acceptance component (Carrière et al., 2022; Mantzios, 2021). Carrière et al. (2022) suggested that only the subscales *awareness*, *external cues* and *distraction* appear to be assessing certain attentional features of mindfulness. However, through cognitive interviews in a sample of pregnant women from the USA, Apolzan et al. (2016) found that most participants showed confusion or misinterpretations of the *external cues* subscale, and

Psychometric properties of the MEQ in Chinese samples

revisions were recommended. Collectively, these findings on the reliability and validity of the MEQ suggest that more detailed investigation of this commonly used questionnaire is warranted.

The validity of the MEQ has not been widely tested beyond US populations, and it is important to evaluate the cultural validity of this assessment before it can be used in particular populations. Of the four studies aiming at cross-culturally validate the MEQ, two failed to replicate its original structure (Clementi et al., 2017; Basir et al., 2021), and three reported low internal consistency of the summary or subscale scores (Abbaspoor et al., 2018; Basir et al., 2021; Román & Urbán, 2019). In the Italian version of the MEQ (Clementi et al., 2017), eight items of the original MEQ were excluded, as 15 professionals working in the area of mindful eating rated them as poorly representative of the construct in an Italian context. Thus, the meaning of the MEQ items for different cultural groups needs to be examined. Finally, the preponderance of MEQ studies are with adults and little is known of its psychometric properties for younger people, nor whether the items are meaningful to them. Lack of a valid measure of mindful eating for adolescents creates barriers to the testing of mindful eating interventions which show efficacy with adults.

We report here on two studies that investigated the psychometric properties of the MEQ in Chinese samples. Study 1 examined how Chinese young adults and adolescents interpreted and responded to a Chinese version of the MEQ (C-MEQ). We used think-aloud interviews which can identify sources of interpretation and/or response errors in survey questionnaires to inform improvements (Apolzan et al., 2016; French et al., 2007; Paterson et al., 2018; Van Oort et al., 2011). Think-aloud methods have also been used in understanding food-decision making processes of young people (Tonkin et al., 2017; Ogden & Roy-Stanley, 2020). Based on the findings of Study 1, the C-MEQ items that yielded major problems in both young adult and adolescent samples were rephrased to produce a revised Chinese version of the MEQ (C-MEQ-R). Study 2 then examined the psychometric properties of the C-MEQ-R. Particularly, this study focused on a sample of Chinese undergraduates. In a transitional period from adolescence to adulthood, undergraduates are experiencing a new environment involving

increased stress and altered forms of life, making them a high-risk group for unhealthy lifestyles and significant weight gain (Hill et al., 2018; 2021; Lyzwinski et al., 2018). Study 2 aimed to: (1) test the psychometric properties of the C-MEQ-R in a sample of Chinese undergraduates; and (2) investigate whether the revision of the questionnaire improved its reliability and validity.

2. Study 1

2.1 Methods

2.1.1 Participants and recruitment

Recruitment calls were posted on WeChat, a popular Chinese social networking application, inviting adolescents aged 16 to 18 years and adults aged 21 to 35 years to participate in a WeChat interview. Inclusion criteria for both samples were: Chinese nationality and fluent in Mandarin; absence of self-report or diagnosed eating disorders; and able to take part in a video interview via WeChat. Seven adults (sample 1) and ten adolescents (sample 2) from Beijing and Jinan (a city in Eastern China) completed the interview. Participants in sample 1 were four females and three males aged from 21 to 35 years ($M = 27.4$; $SD = 4.28$), all well educated with an average of 18.1 years of schooling. Participants in sample 2 were ten Chinese high school students (six females and four males) aged between 16 and 18 years ($M = 16.9$, $SD = 0.74$). The sample size in this study was similar to previous think-aloud studies exploring engagement with measures (Apolzan et al., 2016; French et al., 2007; Van Oort et al., 2011). No participants declared being experienced in mindfulness or meditation practice. This study was approved by the University of Leeds Research Ethics Committee (Faculty of Medicine and Health; reference: 17-0169; date: 07, June 2017).

2.1.2 Materials

The original version of the MEQ (Framson et al., 2009) was translated into Simplified Chinese by a native Mandarin-speaking Psychology PhD student. The wording of validated

Psychometric properties of the MEQ in Chinese samples

Chinese version of mindfulness scales, including the Chinese version of the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006; Deng et al., 2011) and the Chinese version of the Mindful Attention Awareness Scale (MAAS; Brown and Ryan, 2003; Deng et al., 2011) were taken as reference in translation. Two additional psychologists who were fluent in Chinese and English, with no experience in mindfulness, back translated it independently. Discussions on inconsistencies were held before all three translators reached an agreement in terms of semantic, conceptual and cultural equivalence to produce a C-MEQ for use in Study 1 (see Supplementary Files, Table S1).

2.1.3 Think aloud interviews

Think aloud interviews have been used extensively to evaluate the problems people may have when completing validated measures (Willis, 2004). Four processes have been proposed to explain how people complete questionnaires or measures: comprehension of the question, retrieval from memory of relevant information, decision making and response generation (Tourangeau, 1985). In think aloud interviews, participants verbalise their thoughts as they read and respond to each item. Participants are not required to explain their thoughts or give any other commentary.

2.1.4 Procedure

Following consent, each participant completed a video interview via WeChat. Both written and verbal instructions for the think-aloud task were adopted from French et al. (2007). The C-MEQ was sent to participants via email in advance of the interview. At interview start, participants practiced thinking aloud in relation to the practice question: “Do you eat more than usual when you feel stressed?” before proceeding through each item on the C-MEQ. The interviewer was off-camera and did not ask questions or interrupt participants but did encourage them to keep going when they fell silent for more than 10 seconds. The interviews were audio-recorded with consent. Participants received ¥30 (£3.3) for taking part.

Psychometric properties of the MEQ in Chinese samples

2.1.5 Analysis

Interviews were transcribed in full. Analysis involved assigning at least one of five categories (described in Table 1) to each MEQ item, a method adopted from previous think aloud studies on measure completion (French et al., 2007; Van Oort et al., 2011). Two researchers, both Chinese-native speakers, independently coded transcripts. The agreement between the two raters was good (Cohen's $k = .87$; Altman, 1991). A third researcher, an English-native speaker, analyzed the transcripts translated into English and examined the coding of the first two coders. Only minor clarifications were sought with regard to justifying coding. Full coding consensus was then achieved.

2.2 Results

2.2.1 Segmenting and coding of think-aloud transcripts

For the adult sample, 7 participants answered 28 items of the MEQ, which generated 196 (7×28) text segments for coding. Of these, 193 (98.5%) were assigned into one of the five categories and three were assigned into two categories (e.g., *re-read* and *misinterpreted* a question). Of the 196 segments, 36 (18.4%) were assigned to category 2 (*failed to provide sufficient information*) and were discounted from the analysis. The coding of the remaining 160 (81.6%) segments identified a total of 43 problems related to 17 items of the MEQ. The frequency and type of problems identified by adult participants for each construct of the MEQ are shown in Table 2.

In the adolescent sample, 10 participants answered 28 items of the MEQ, generating 280 (10×28) codable segments. Of these, 274 (97.9%) segments were assigned into one of the five categories (described in Table 1), and 6 segments identified 2 problems and therefore were assigned into 2 categories (e.g., *re-read* and *misinterpreted* a question). Seventy-eight (27.9%) segments were coded as *no sufficient thinking aloud* and were discounted from further analysis. The remaining 202 (72.1%) segments represented a total of 68 problems relating to 16 items of the MEQ. The frequency and type of problematic segments of adolescent participants for each construct of the MEQ is shown in Table 3.

Psychometric properties of the MEQ in Chinese samples

Taken together, 19 items of the MEQ yielded a total of 111 problems across the two samples, of which 14 items were problematic for both samples, although adolescents reported slightly more problems on average. Eleven items generated more than three problems each (ranging from 4 to 19). Examples illustrating the two main types of problems (i.e., *problems understanding* and *misinterpretation*) related to each of these 11 items are shown in Supplementary Files, Table S2. The remaining nine questions of the MEQ yielded no problems for either samples.

2.2.2 Identified problems related to MEQ subscales

External cues

The *external cues* subscale generated most problems in both samples, accounting 60.4% (n = 43) of total problems identified for adult sample and 58.8% (n = 40) for adolescent sample (see Table 2 and Table 3). Taken together, 52 misinterpretations and 8 explicitly reported difficulties in understanding or answering the items were identified related to the six items of this subscale. The examination of Table S2 suggested that most of the problems (51 misinterpretations and at least 1 identified difficulty in answering the question) were caused by item structure on this subscale. All six items structured as ‘I notice/recognise when + a situation’ (e.g., “I notice when just going into a movie theatre makes me want to eat candy or popcorn”) which were designed to evaluate respondents’ awareness and noticing of their externally driven eating behaviour rather than the behaviour itself. However, most of our adult and adolescent participants responded to the items by considering whether the behaviour ever occurred, rather than on their ability to notice it when it happened. For example:

Q8: “Rarely. I rarely eat sweets or popcorn at movie theatres. I don’t like popcorn or sweets; don’t like these kinds of food. Except when the smell is very good and I’m too hungry, I might

Psychometric properties of the MEQ in Chinese samples

choose to have some. Otherwise, rarely.” (S1, PP3, female)¹

Q14: “...I think I feel very happy when I eat a big meal, and I eat a lot of the food I like, so of course I don't feel heavy or sluggish. Definitely not. I choose 1 (never/rarely).” (S2, PP10, female)

Two adult participants expressed confusion over the structure of the *external cues* questions, e.g. “(Q23)...One thing I'm not sure about this question is that, when I choose 'sometimes' or 'often', does it mean I often recognise this thing, or I often eat when not hungry. I'm not sure which part this word is supposed to describe. For me, when I'm eating and not hungry, I always recognise it; however, I don't often eat when not hungry.” (S1, PP1, female)

Awareness

Four out of seven items of *awareness* subscale generated problems in both samples. Similar to the *external cues* subscale, most of these problems (12 misinterpretations and 2 identified difficulty in answering the question) were related to the 'noticing' questions. For example, when answering item 26 ('I notice when the food I eat affects my emotional state'), eight problems were identified related to 'noticing'. Participants often responded by considering if food had ever affected their emotional state, rather than their level of noticing the effect on food on them in the moment, e.g. “Often so, when the food I eat is not good, or not to my taste, or too spicy or too salty or too bland. It did quite often affect my emotional state.” (S2, PP4, male). Two adult participants expressed their confusion over the structure of this question, e.g. “Does this question ask whether I notice it, or whether food affects my emotional state? If it asks whether I notice it, then I often notice it; however, my emotional state is rarely affected by food.” (S1, PP4, female).

Another problem revealed was that the participants interpreted some items on noticing as questioning their passive and/or per chance awareness rather than their conscious intention to

¹ S = sample; PP = participant

Psychometric properties of the MEQ in Chinese samples

notice moment-by-moment experience, on purpose. For example, item 16 ('I appreciate the way my food looks on my plate') generated five misinterpretations as the act of 'appreciating' was interpreted as a passive consequence that mostly depended on the characteristics of the food rather than an intentional act, e.g. *"Let me think about it, think about whether there was food that looked beautiful. Sometimes I do, sometimes it looks disgusting, and I don't appreciate it."* (S1, PP5, male). In response to the item 'I notice when there are subtle flavours in the foods that I eat' (item 10), three participants spoke about their taste sensitivity, e.g. *"I always notice it, as my sense of taste is very sharp"* (S1, PP2, male). Such responses appear appropriate to the question, but they do not reflect intention to notice, which is the mindful construct that the C-MEQ is attempting to assess.

In addition, the phrase 'subtle flavours' of item 10 generated confusion and misunderstanding, particularly among adolescents. Three adolescents identified "subtle flavours" as "strange tastes" or "tastes different than usual", e.g. *"Yes. If it's something I've had before, it's obvious when it tastes different than usual."* (S2, PP1, male). One adult and three adolescents showed to be confused over the exact meaning of "subtle flavours", e.g. *"Subtle flavours... I'm not sure if I understand this word correctly, as I don't see it a lot. There are only several kinds of meals from home to school refectory, and I never taste any subtle flavours in them even though I've already got bored of them."* (S2, PP4, male)

Disinhibition

Only one item (item 18: 'If there's good food at a party, I'll continue eating even after I'm full.') of this subscale generated major problems. While the item is attempting to assess the extent to which people are mindful of their hunger and satiety, two adults and two adolescents interpreted this behaviour as rude and reported they would not do it as a matter of courtesy, e.g. *"Rarely. I care about my image at public events like parties, or you can say I'm more likely to control myself in front of others. Usually I tend to indulge myself when I'm alone."* (S1, PP1, female).

Items on the other two subscales (i.e., *distraction* and *emotional responses*) generated no or only minor problems and therefore are not specified here.

2.3 Discussion

Both young adult and adolescent respondents encountered a wide range of problems when completing the C-MEQ. Overall, the problems identified were similar across the two samples. The majority of the problems were item misinterpretation (N = 85), raising questions about the meaningfulness of participants' responses.

The main problems were related to the items structured as 'I notice/recognise + a situation' on *external cues* and *awareness* subscales. When answering these items, most participants referred to their own behaviour rather than the act of noticing. These findings are in line with those of Apolzan et al. (2016) who found that a US adult sample only talked about the behaviour in *external cues* questions, or reported their confusion over the questions. A further challenge in the C-MEQ was the focus on intention to notice, which posed different problems to those around noticing vs. behaving. In line with Grossman's (2008) concerns, our respondents tended to comprehend the act of 'noticing' as an unintentional and passive awareness, or focus on their general ability to notice the situation described in question. This interpretation is inconsistent with the meaning of mindful eating.

Our findings point to the challenges of completing the C-MEQ when respondents are unfamiliar with mindfulness, and specifically with mindful (intentional) noticing. We therefore propose that the comprehension and validity of the measure could be improved by greater emphasis on a person's *intention to notice* eating behaviours and their consequences. This change would better align the C-MEQ with dominant conceptualisations of mindfulness as intentionally paying attention to present-moment experience (with certain attitudes) (e.g., Bishop et al., 2010; Shapiro et al., 2010). Many generic mindfulness scales assess intention to notice (Bergomi et al., 2013). For example, the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), asks 'When I'm walking, I *deliberately notice* the sensations of my body moving' (item 1), or 'I *pay attention to* how my emotions affect my thoughts and

behaviour' (item 36).

Based on these findings, we suggest that the problematic awareness-related items of the C-MEQ, i.e., items for *awareness* and *external cues* subscales with identified problems, could be rephrased to ask about intentional noticing to either internal experiences or external cues. We present suggested revisions to ten items in Table 4, most of which incorporate the phrase 'deliberately notice' in order to distinguish between the act or event, and the purposeful noticing of it.

Two further items were problematic for different reasons. The confusion and misinterpretations regarding the phrase 'subtle flavours' in item 10 of the *awareness* subscale might have been caused by language nuances, as in Chinese 'subtle flavours' can be confused with 'subtle tastes'. In addition, more adolescents reported difficulties in understanding 'subtle flavours' than adults. These adolescents tended to have a relatively monotonous diet. When applying the questionnaire to adolescents, the relevance of items to their daily life should be taken into consideration. The problems related to item 18 on *disinhibition* showed how the respondents' eating behaviour can be strongly influenced by social context in addition to individual choice (Higgs & Thomas, 2016). We did not propose revision to this item as only one out of eight items on this subscale yielded problems. Therefore, informed by these findings, the next steps were to: (1) test the psychometric properties of the C-MEQ-R in a sample of Chinese undergraduates; and (2) investigate whether the revision of the questionnaire improved its reliability and validity.

3. Study 2

3.1 Methods

3.1.1 Participants and Recruitment

Participants were recruited from an art university in Jinan, East China. A head teacher of the university gave permission for recruitment and administration of the study. An e-copy of the survey with an informed consent form was sent to the head teacher, who distributed and

Psychometric properties of the MEQ in Chinese samples

collected measures. Undergraduates of the university were invited to take part. Inclusion criteria were: Chinese nationality and fluent in Chinese; aged over 18 years; willing to participate in a brief survey study. Participation was anonymous. This study was approved by the University of Leeds School of Psychology Research Ethics Committee (PSC-358; date: 26, June 2018).

We received 520 questionnaires, of which 47 (9.0%) did not provide demographic information, and 43 (8.3%) showed unsatisfactory quality (defined as more than 25% of the questions not completed or straight-lining / patterned responses). The final sample consisted of 430 Chinese university students aged 18 to 35 years ($M = 19.55$ years, $SD = 2.11$), of which 73.5% were female ($n = 316$). The mean self-reported BMI of the sample was 20.14kg/m^2 (ranging from 14.52 to 32.65 kg/m^2 ; $SD = 2.63$). One third ($n = 143$) of the participants reported to be on a weight loss diet.

3.1.2 Design and measures

Participants filled out a cross-sectional paper-based survey that included questions regarding eating-related demographics (e.g., age, sex, weight, height) and the following measures. The survey took up to 15 minutes.

Chinese version of the Mindful Eating Behaviour (C-MEQ) and revised items To achieve the two study aims, we administered the original 28-item C-MEQ, followed by our 10 revised items as shown in Table 4.

Dutch Eating Behaviour Questionnaire (DEBQ) Emotional eating and external eating were assessed using the DEBQ (Van Strien et al., 1986). The DEBQ consists of 33 items assessing three obesity-related eating styles (i.e., emotional eating, external eating and restrained eating), with the response to each question from 1 (never) to 5 (very often). A validated Chinese version of the DEBQ (Wu et al., 2017) was used in the current study. Cronbach's α of the DEBQ in the present sample was: *emotional eating* (.92); *external eating* (.74).

Five Facet Mindfulness Questionnaire (FFMQ) Mindfulness was assessed using the FFMQ (Baer et al., 2006). The FFMQ is one of the most extensively validated measures of mindfulness (Sauer et al., 2013), which captures five factors of mindfulness (i.e., observing, describing, act with awareness, non-judging of inner experience, and non-reactivity to inner experience). The questionnaire consists of 39 statements with the response to each item from 1 (never or very rarely true) to 5 (very often or always true). A validated Chinese version of the FFMQ (Deng et al., 2011) was used in the current study. In Deng et al.'s (2011) study, the Ch-FFMQ showed acceptable internal reliability for all subscales except for *non-reactivity* (Cronbach's $\alpha = .45$) among a sample of Chinese undergraduates. In the present sample, the FFMQ showed similar Cronbach's α : *observing* (.72); *describing* (.64); *act with awareness* (.78); *non-judging* (.71); *non-reactivity* (.48).

3.1.3 Statistical analysis

Statistical analysis was conducted using SPSS 22.0 and R version 4.1.3. Missing data for all items was less than 2.5% (ranging from 0 to 2.3%). Little's MCAR test suggested that the data was missing completely at random ($\chi^2 = 738.30$, $df = 743$, $p = .542$). Therefore, the expectation-maximization algorithm was used to handle with missing data.

For both C-MEQ and C-MEQ-R, confirmatory factor analysis (CFA) was firstly conducted to investigate if the original five-factor structure of the MEQ fit the current dataset. The CFA was performed using the lavaan package (Rosseel, 2012) with the weighted least squares means and variance adjusted (WLSMV) estimator, which provides a robust estimation of ordinal data (Beauducel & Herzberg, 2006). This is followed by Exploratory Structural Equation Modeling (ESEM) performed using psych (Makowski, 2018) and lavaan (Rosseel, 2012) packages in R. The CFA has been argued to be too restrictive for multidimensional constructs by forcing cross-loadings to be zero, which can result in inflated CFA factor correlations and biased estimates (Marsh et al., 2014). Integrating the advanced features of CFA and EFA (i.e., exploratory factor analysis), ESEM provides a more

appropriate examination of factor structure by simultaneously allowing for cross-loadings and providing a model fit index (Asparouhov & Muthén, 2009; Marsh et al., 2014). When conducting ESEM, it is recommended to investigate multiple solutions and compare the ESEM model to the CFA models where *a priori* theoretical structure exists (Asparouhov & Muthén, 2009; Marsh et al., 2014). In the current study, for both C-MEQ and C-MEQ-R, a five-factor model was firstly examined with geominQ rotation and WLSMV estimator, then a four-factor model for C-MEQ-R was also examined as the method agreement procedure in psych package suggested. Multiple fit indices were evaluated, including the chi-square fit index, comparative fit index (CFI; $\geq .95$ for good, $\geq .90$ for acceptable), Tucker-Lewis index (TLI; $\geq .95$ for good, $\geq .90$ for acceptable), the standardized root mean square residual (SRMR; $\leq .08$ for good) and root mean square error of approximation (RMSEA; $\leq .06$ for good, $\leq .08$ for acceptable) (Chen, 2007; Hu & Bentler, 1999).

Internal reliability of the subsequent factors of both questionnaires was examined using Cronbach's alpha with the usual guidelines (0.70 as acceptable; 0.80 as good) (Nunnally, 1978). Respondents' scores on the final version of the C-MEQ-R were correlated with the FFMQ and the DEBQ to assess convergent and divergent validity. As mindful eating is an application of mindfulness principles to eating, we proposed that there would be a moderate correlation between the C-MEQ-R and the FFMQ. Theoretically, mindful eating should be negatively associated with emotional eating and external eating (O'Reilly et al., 2014). We thus expected negative correlations between the C-MEQ-R and emotional eating and external eating scales of the DEBQ. We also examined the relation between respondents' BMI and scores on the C-MEQ-R. To compare the convergent validity of the C-MEQ and the C-MEQ-R, correlations between the C-MEQ and other measures were also calculated.

3.2 Results

3.2.1: CFA and ESEM with the C-MEQ and the C-MEQ-R

Model fit indices of all five models are shown in Table 5. The five-factor CFA model showed inadequate fit to the data of both C-MEQ and C-MEQ-R. The five-factor ESEM solution had

Psychometric properties of the MEQ in Chinese samples

superior fit for C-MEQ and C-MEQ-R. The four-factor ESEM solution for C-MEQ-R showed generally acceptable fit but was outperformed by the five-factor model. Inspections of the factor loadings also favoured the five-factor model as the four-factor solution yielded more items with low factor loadings ($< .30$). Therefore, for both questionnaires, the five-factor ESEM models were selected for subsequent analysis.

Factor loadings of the 5-factor ESEM model for C-MEQ are presented in Table S3 (supplementary files). Five items (item 1, 4, 14, 26, 27) showed low factor loadings ($< |.30|$) on all factors and were excluded for further analysis (Tabachnick & Fidell, 2018). Four items (item 6, 10, 12 and 15) showed high loadings on more than one factor. Factor 1 consisted of seven out of eight items (item 2, 5, 7, 9, 11, 15, 18) on the *disinhibition* subscale, and factor 2 consisted of three out of seven items (item 16, 21, 22) on the *awareness* subscale of the original MEQ. Factor 3 (item 12, 17, 19), 4 (item 6, 8, 13, 23, 24) and 5 (item 3, 10, 20, 25, 28) combined items on several subscales of the original questionnaire, and all had items with cross-loadings or negative factor loadings, which were difficult to be interpreted.

Factor loadings of the 5-factor ESEM model C-MEQ-R are presented in Table 6. Three items (item 1, 27, 28) showed low factor loadings ($< |.30|$) on all factors and were excluded for further analysis (Tabachnick & Fidell, 2018). One item (item 10) showed high loadings on more than one factor. Factor 1 included seven items (item 3, 4, 8, 12, 14, 24, 26) which were clearly associated with *intentional awareness* of how food or food-related stimuli affect one's physical and emotional states. Factor 2 included seven items (item 2, 5, 7, 9, 11, 15, 18) on the *disinhibition* subscale of the original MEQ. Factor 3 consisted of seven items (item 10, 16, 20, 21, 22, 23, 25) mainly describing intentional attending to the properties of food while eating, which can be seen as a reflection of *attentive eating*. Factor 4 consisted of two items (item 17, 19) on the *emotional response* subscale of the original MEQ. Factor 5 consisted of two items (item 6, 13) describing eating without noticing or paying attention, which can be labelled as *distraction*. Therefore, five domains labeled as *intentional awareness*, *disinhibition*, *attentive eating*, *emotional response*, and *distraction* were identified. Descriptive statistics of and intercorrelation between subscales are shown in Table 7.

Psychometric properties of the MEQ in Chinese samples

3.2.2: Reliability analysis of the C-MEQ and the C-MEQ-R

Reliability analysis with both questionnaires was carried out based on the ESEM models. For the C-MEQ, as shown in Table S3, only one factor showed acceptable internal consistency (factor 1: $\alpha = .70$). The other four factors showed low internal consistency (ranging from $-.05$ to $.61$). The internal consistency of the whole questionnaire was poor (Cronbach's $\alpha = .52$). Compared to the C-MEQ, the C-MEQ-R showed better but still questionable internal consistency (Cronbach's $\alpha = .63$). As shown in Table 6, two factors showed acceptable internal consistency (*Intentional Awareness*: $.71$; *Disinhibition*: $.70$). The other factors showed unsatisfactory internal consistency (ranging from $.34$ to $.69$).

3.2.3: Correlations of the C-MEQ and the C-MEQ-R with other variables

As shown in Table 8, the C-MEQ-R was positively correlated with the FFMQ ($r = .32$; $p < .001$). All subscales except for *emotional response* showed a positive correlation with the FFMQ. The C-MEQ-R was negatively correlated with *emotional eating* ($r = -.42$; $p < .001$) and *external eating* ($r = -.27$; $p < .001$) on the DEBQ as expected, although interestingly, some subscales showed positive correlations with these unhealthy eating styles. There was also a significantly negative correlation between the C-MEQ-R and BMI ($r = -.10$, $p < .05$).

Correlations between the C-MEQ and other measures are also shown in Table 8. Similar to the C-MEQ-R, the C-MEQ also showed a positive correlation with the FFMQ ($r = .25$; $p < .001$), and was negatively correlated with *emotional eating* ($r = -.26$; $p < .001$) on the DEBQ. However, compared to the C-MEQ-R, the C-MEQ showed less stronger correlations with the FFMQ and *emotional eating*. The C-MEQ was not significantly correlated with *external eating* on the DEBQ or BMI.

3.3. Discussion

This study examined the psychometric properties of a revised Chinese version of the MEQ (C-MEQ-R) in comparison to a Chinese version of the MEQ without revision (C-MEQ). The results of the CFA on both C-MEQ and C-MEQ-R revealed an inadequate fit to the original model. This is in line with previous studies aiming at cross-culturally validate the MEQ

Psychometric properties of the MEQ in Chinese samples

which failed to replicate its original structure (Clementi et al., 2017; Basir et al., 2021), suggesting an unstable internal structure of the MEQ. The selected ESEM model of the C-MEQ-R consists of 25 items that make up five domains: *intentional awareness*, *disinhibition*, *attentive eating*, *emotional response* and *distraction*.

Of the five domains of the C-MEQ-R, *disinhibition* and *emotional response* were very similar to the original MEQ. *Emotional response* consisted of two of the four items on emotional response subscale of the original MEQ. Item 27 were dropped and item 13 loaded on the *distraction* subscale. As reported by Framson et al. (2009), these items were originally developed to assess external cues (item 27) and distraction (item 13), but unexpectedly loaded on the *emotional response* factor. They suggested that the clustering of these items might reflect a unique characteristic of the study sample. *Disinhibition* of the C-MEQ-R contains seven of the eight items on disinhibition subscale of the original MEQ. The only difference was item 25 ('When I'm at a restaurant, I can tell when the portion I've been served is too large for me'). This item loaded on another factor associated with individuals' intentional attending to the properties of food consumed, which was labeled as *attentive eating*. Attentive eating has been suggested as a key mindful eating strategy (Warren et al., 2017). It appears reasonable that item 25 loaded on this factor, as it too describes awareness of food properties (i.e. portion size).

Interestingly, seven of the 10 revised items loaded on the same factor. These items were originally designed to evaluate respondents' awareness of how food or food-related stimuli affect their physical and emotional sensations. However, from the think-aloud study, we found that participants tended to respond by considering whether the situation ever occurred, rather than on their noticing of it as it happened. Based on these findings, we rephrased these items with a specific emphasis on intentional noticing. Therefore, this factor was labeled as *intentional awareness*. It should be noted that two subscales, *emotional response* and the *distraction*, included only two items, which might be inadequate to represent a sub-construct.

The internal reliability for the summary score of the C-MEQ-R and three out of five subscales were lower than 0.70. Cronbach's alpha for the MEQ was 0.63, which is similar to

some of the previous studies using the original MEQ (Anderson et al., 2016; Apolzan et al., 2016; Goodwin et al., 2017) or cross-culturally validating the questionnaire (Abbaspoor et al., 2018; Basir et al., 2021; Román & Urbán, 2019). The *distraction* subscale exhibited particularly low internal consistency, which is consistent with previous studies (Beshara et al., 2013; Dibb-Smith et al., 2019; Moor et al., 2013). These findings of the present study added to the accumulating evidence suggesting that the MEQ may not be internally consistent.

The C-MEQ-R summary score were significantly correlated with the FFMQ as well as *emotional eating* and *external eating* of the DEBQ in expected direction, indicating good preliminary convergent validity. However, there were some unexpected findings regarding associations between the C-MEQ-R subscales and theoretically related measures. For example, negative associations were found between subscales. This is in line with previous studies indicating the lack of cohesion between the MEQ subscales (Apolzan et al., 2016; Román & Urbán, 2019).

In addition, scores on *intentional awareness* were positively correlated with *emotional eating* and *external eating* of the DEBQ. A longitudinal study with a sample of 300 young women found that higher scores on *observing* (i.e., tendency to notice internal and external stimuli) of the FFMQ predicted higher emotional and external eating across six months (Sala & Levinson, 2017). The authors suggested that the increased awareness of emotional and external cues might lead to eating in response to such cues. In the context of mindful eating, it was expected that increased awareness of triggers for eating and eating-related experiences could interrupt the automatic processes of emotional eating and external eating, and therefore enabling intentional behavioural regulation on these eating behaviours (Warren et al., 2017). However, as most of our participants were young adults who probably had little experience in mindfulness or mindful eating, noticing eating-related emotional or external stimuli does not necessarily mean they would have intentions or skills to regulate their behaviours accordingly. In the present study, *intentional awareness* of the C-MEQ-R was positively correlated with *observing*, *describing* and *non-reactivity*, but negatively correlated with *act*

Psychometric properties of the MEQ in Chinese samples

with awareness and *non-judging* of the FFMQ. This suggested that in our sample, those who tended to notice or attend to eating-related experiences were less accepting of their inner experience, and more likely to act on automatic pilot. Therefore, their awareness of external and internal eating triggers could lead to increased but not decreased eating behaviours.

Similarly, scores on *attentive eating* was positively correlated with *external eating*. In mindfulness-based approaches for healthy eating and weight control, participants are guided to pay close attention to sensory properties of food, through which their eating pleasure and memory for food consumed could be enhanced (Arch et al., 2016; Robinson et al., 2014). However, for individuals who had no experience in mindfulness, tendency to attending to food properties could partially reflect their interest in food. Participants who scored higher on *attentive eating* could be more interested in food or more attentive to external food cues, and therefore reported higher levels of external eating. In addition, similar to *intentional awareness* discussed above, *attentive eating* was also shown to be negatively correlated with *non-judging* on the FFMQ. One important critique of the MEQ was that it failed to measure the acceptance component of mindful eating (Carrière et al., 2022; Hulbert-Williams et al., 2014). The present study found that attention to and awareness of eating experiences measured by the MEQ was not necessarily accompanied by acceptance of these experiences, highlighting the critical limitation of the construct validity of the MEQ.

Overall, the C-MEQ-R showed better factor structure validity, internal reliability and convergent validity compared to the C-MEQ. However, several problems were identified with this questionnaire, including low internal reliability, lack of concordance between subscales, and limited construct validity. These findings are supported by many of the previous empirical results and theoretical critiques in relation to the original or culturally adopted version of the MEQ, suggesting these deficiencies in psychometric properties may not be unique to the present version. These psychometric limitations of the MEQ should be taken into consideration when interpreting existing evidence using this questionnaire. Future studies should consider using alternative assessments of mindful eating such as the Mindful Eating Inventory (Peitz et al., 2021) and the Four Facet Mindful Eating Scale (Carrière et al.,

2022), and establishing psychometric properties of these newly developed mindful eating assessments in diverse populations.

4. Limitations and conclusions

There are some limitations to the studies we report. First, the sample size of the think-aloud study was small, although similar to previous think-aloud studies exploring engagement with measures (French et al., 2007; Paterson et al., 2018; Van Oort et al., 2011). The adult sample was not representative of the Chinese population, being better educated. The sample recruited to Study 2 consisted mostly of females, which limits the generalisability of the findings. Study 2 did not ask participants to specify their meditation experience. However, their average scores on the FFMQ were similar to those of previous studies with Chinese young adults without long-term meditation experience (Liu et al., 2013; Xu et al., 2015), indicating most of our participants were likely to have limited experiences in mindfulness or meditation. Future studies should identify the familiarity of participants with mindfulness and meditation or compare the psychometric properties of the measures between meditators and non-meditators. Finally, caution is warranted in generalising the findings of the Chinese MEQ to the original English version.

In conclusion, to our knowledge, this was the first attempt to explore the psychometric property of a mindful eating assessment in Chinese adolescents and young adults. Taken together, the two studies identified a series of deficiencies of the Chinese version of the MEQ using mixed methods. The qualitative investigations revealed low content validity of the C-MEQ, as participants tended to misinterpret scale items. The quantitative results demonstrated unstable internal structure, low internal reliability and limited construct validity of the questionnaire, although the revisions based on qualitative results had improved its psychometric properties. These findings contribute to the progress in the measurement of mindful eating by highlighting the weaknesses of the MEQ. Given major concerns with the high and increasing overweight/obesity prevalence among Chinese adolescents and young adults, further research is called to adopt and validate alternative mindful eating assessments

for understanding eating style and testing mindfulness-based approaches in this group.

Author contributions: All authors contributed to the study conception and design. Material preparation, data collection and analysis were mainly performed by the first author and supervised by the second and the third author. The first draft of the manuscript was written by the first author and all authors commented on previous versions of the manuscript. All authors have read and approved the final article.

Funding: This study was conducted as part of a PhD programme. Funding was allocated by the University of Leeds as a part of this degree.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Reference

- Abbaspoor, Z., Javadifar, N., Miryan, M., & Abedi, P. (2018). Psychometric properties of the Iranian version of mindful eating questionnaire in women who seeking weight reduction. *Journal of Eating Disorders*, 6, 33. <https://doi.org/10.1186/s40337-018-0220-4>
- Altman, D. G. (1991). *Practical statistics for medical research*. London: Chapman and Hall.
- Anderson, L. M., Reilly, E. E., Schaumberg, K., Dmochowski, S., & Anderson, D. A. (2016). Contributions of mindful eating, intuitive eating, and restraint to BMI, disordered eating, and meal consumption in college students. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 21(1), 83-90. <https://doi.org/10.1007/s40519-015-0210-3>
- Apolzan, J. W., Myers, C. A., Cowley, A. D., Brady, H., Hsia, D. S., Stewart, T. M., Redman, L. M., & Martin, C. K. (2016). Examination of the reliability and validity of the mindful eating questionnaire in pregnant women. *Appetite*, 100, 142-151. <https://doi.org/10.1016/j.appet.2016.02.025>

Psychometric properties of the MEQ in Chinese samples

- Arch, J. J., Brown, K. W., Goodman, R. J., Della Porta, M. D., Kiken, L. G., & Tillman, S. (2016). Enjoying food without caloric cost: the impact of brief mindfulness on laboratory eating outcomes. *Behaviour Research and Therapy*, *79*, 23-34. <https://doi.org/10.1016/j.brat.2016.02.002>
- Asparouhov, T., & Muthén, B. (2009). Exploratory structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, *16*(3), 397-438. <https://doi.org/10.1080/10705510903008204>
- Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using Self-Report Assessment Methods to Explore Facets of Mindfulness. *Assessment*, *13*(1), 27-45. <https://doi.org/10.1177/1073191105283504>
- Basir S. M. A., Manaf, Z. A., Ahmad, M., Kadir, N. B. A., Ismail, W. N., Ludin, A. F. M., & Shahar, S. (2021). Reliability and validity of the Malay Mindful Eating Questionnaire (MEQ-M) among overweight and obese adults. *International Journal of Environmental Research and Public Health*, *18*(3), 1021. <https://doi.org/10.3390/ijerph18031021>
- Bergomi, C., Tschacher, W., & Kupper, Z. (2013). The assessment of mindfulness with self-report measures: Existing scales and open issues. *Mindfulness*, *4*(3), 191-202. <https://doi.org/10.1007/s12671-012-0110-9>
- Beshara, M., Hutchinson, A. D., & Wilson, C. (2013). Does mindfulness matter? Everyday mindfulness, mindful eating and self-reported serving size of energy dense foods among a sample of South Australian adults. *Appetite*, *67*, 25-29. <https://doi.org/10.1016/j.appet.2013.03.012>
- Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., Segal, Z. V., Abbey, S., Speca, M., Velting, D., & Devins, G. (2010). Mindfulness: A proposed operational definition. *Clinical Psychology Science & Practice*, *11*(3), 230-241. <https://doi.org/10.1093/clipsy.bph077>
- Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4),

822-848. <https://doi.org/10.1037/0022-3514.84.4.822>

- Beauducel, A., & Herzberg, P. Y. (2006). On the performance of maximum likelihood versus means and variance adjusted weighted least squares estimation in CFA. *Structural Equation Modeling: A Multidisciplinary Journal*, 13(2), 186-203. https://doi.org/10.1207/s15328007sem1302_2
- Carrière, K., Houry, B., Günak, M. M., & Knäuper, B. (2018). Mindfulness-based interventions for weight loss: a systematic review and meta-analysis. *Obesity Reviews*, 19(2), 164-177. <https://doi.org/10.1111/obr.12623>
- Carrière, K., Shireen, S. H., Siemers, N., Preißner, C. E., Starr, J., Falk, C., & Knäuper, B. (2022). Development and Validation of the Four Facet Mindful Eating Scale (FFaMES), *Appetite*, 168, 105689. <https://doi.org/10.1016/j.appet.2021.105689>
- Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, 14(3), 464-504. <https://doi.org/10.1080/10705510701301834>
- Chen, Y., Peng, Q., Yang, Y., Zheng, S., Wang, Y., & Lu, W. (2019). The prevalence and increasing trends of overweight, general obesity, and abdominal obesity among Chinese adults: a repeated cross-sectional study. *BMC Public Health*, 19, 1293. <https://doi.org/10.1186/s12889-019-7633-0>
- Clementi, C., Casu, G., & Gremigni, P. (2017) An abbreviated version of the Mindful Eating Questionnaire. *Journal of Nutrition Education and Behavior*, 49(4), 352-356. <https://doi:10.1016/j.jneb.2017.01.016>
- Deng, Y-Q, Li, S., Tang, Y-Y., Zhu, L-H., Ryan, R., & Brown, K. (2012). Psychometric properties of the Chinese translation of the Mindful Awareness Scale (MAAS). *Mindfulness*, 3, 10-14. <https://doi.org/10.1007/s12671-011-0074-1>
- Deng, Y-Q., Liu, X-H., Rodrigues, M. A., & Xia, C-Y. (2011). The five facet mindfulness questionnaire: psychometric properties of the Chinese version. *Mindfulness*, 2(2), 123-128. <https://doi.org/10.1016/j.jneb.2017.01.016>
- Dibb-Smith, A., Chapman, J., & Brindal, E. (2019). Breaking habits with mindful snacking?

Psychometric properties of the MEQ in Chinese samples

- An email-based intervention targeting unwanted snacking habits in an Australian sample. *Eating Behaviors*, 32, 37-43. <https://doi.org/10.1016/j.eatbeh.2018.11.006>
- Dunn, C., Haubenreiser, M., Johnson, M., Nordby, K., Aggarwal, S., Myer, S., & Thomas, C. (2018). Mindfulness approaches and weight loss, weight maintenance, and weight regain. *Current obesity reports*, 7(1), 37-49. <https://doi.org/10.1007/s13679-018-0299-6>
- Framson, C., Kristal, A. R., Schenk, J. M., Littman, A. J., Zeliadt, S., & Benitez, D. (2009). Development and validation of the mindful eating questionnaire. *Journal of the American Dietetic Association*, 109(8), 1439-1444. <https://doi.org/10.1016/j.jada.2009.05.006>
- French, D. P., Cooke, R., Mclean, N., Williams, M., & Sutton, S. (2007). What do people think about when they answer Theory of Planned Behaviour questionnaires? A think aloud study. *Journal of health psychology*, 12(4), 672-687. <https://doi.org/10.1177/1359105307078174>
- Goodwin, R., Lucio, J., Vega-López, S., & Bruening, M. (2017). Exploring mindful eating and weight status among underserved youth and their parents living in public housing. *Mindfulness*, 8(4), 973-983. <https://doi.org/10.1007/s12671-016-0674-x>
- Grossman, P. (2008). On measuring mindfulness in psychosomatic and psychological research. *Journal of psychosomatic research*, 64(4), 405-408. <https://doi.org/10.1016/j.jpsychores.2008.02.001>
- Guo, Y., Yin, X., Wu, H., Chai, X., & Yang, X. (2019). Trends in overweight and obesity among children and adolescents in China from 1991 to 2015: a meta-analysis. *International Journal of Environmental Research and Public Health*, 16, 4656. <https://doi.org/10.3390/ijerph16234656>
- Higgs, S., & Thomas, J. (2016). Social influences on eating. *Current Opinion in Behavioral Sciences*, 9, 1-6. <http://dx.doi.org/10.1016/j.cobeha.2015.10.005>
- Hill, D.C, Conner, M., Clancy, F., Moss, R., Bristow, M., O'Connor, D.B. (2021). Stress and eating behaviours in adults: A systematic review and meta-analysis. *Health*

Psychometric properties of the MEQ in Chinese samples

Psychology Review. In press.

- Hill, D.C., Moss, R.H., Sykes-Muskett, B., Conner, M., O'Connor, D.B. (2018). Stress and eating behaviors in children and adolescents: Systematic review and meta-analysis. *Appetite*, 123, 14-22.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1-55. <https://doi.org/10.1080/10705519909540118>
- Hulbert-Williams, L., Nicholls, W., Joy, J., & Hulbert-Williams, N. (2014). Initial validation of the mindful eating scale. *Mindfulness*, 5(6), 719-729. <https://doi.org/10.1007/s12671-013-0227-5>
- Liu, X., Xu, W., Wang, Y., Williams, M. G., Geng, Y., Zhang, Q., & Liu, X. (2015). Can inner peace be improved by mindfulness training: a randomized controlled trial. *Stress and Health*, 31, 245-254. <https://doi.org/10.1002/smi.2551>
- Lyzwinski, L. N., Caffery, L., Bambling, M., & Edirippulige, S. (2018). Relationships between mindfulness, weight, and weight-related behaviors in college students: a systematic review. *Alternative and Complementary Therapies*, 24(5), 202-214. <http://doi.org/10.1089/act.2018.29182.lnl>
- Makowski, D. (2018). The psycho package: an efficient and publishing-oriented workflow for psychological science. *The Journal of Open Source Software*, 3(22), 470. <https://doi.org/10.21105/joss.00470>
- Mantzios, M. (2021). (Re)defining mindful eating into mindful eating behaviour to advance scientific enquiry. *Nutrition and Health*, 27(4), 367-371. <https://doi.org/10.1177/0260106020984091>
- Marsh, H. W., Morin, A. J. S., Parker, P. D., & Kaur, G. (2014). Exploratory Structural Equation Modeling: an integration of the best features. *Annual Review of Clinical Psychology*, 10, 85-110. <https://doi.org/10.1146/annurev-clinpsy-032813-153700>
- Martin, R., Prichard, I., Hutchinson, A. D., & Wilson, C. (2013). The role of body awareness and mindfulness in the relationship between exercise and eating behavior. *Journal of*

Psychometric properties of the MEQ in Chinese samples

- Sport and Exercise Psychology*, 35(6), 655-660. <https://doi.org/10.1123/jsep.35.6.655>
- Mason, A. E., Epel, E. S., Kristeller, J., Moran, P. J., Dallman, M., Lusting, R. H., Acree, M., Bacchetti, P., Laraia, B. A., Hecht, F. M., & Daubenmier, J. (2016) Effects of a mindfulness-based intervention on mindful eating, sweets consumption, and fasting glucose levels in obese adults: data from the SHINE randomized controlled trial. *Journal of behavioral medicine*, 39(2), 201-213. <https://doi.org/10.1007/s10865-015-9692-8>
- Moor, K. R., Scott, A. J., & McIntosh, W. D. (2013). Mindful eating and its relationship to body mass index and physical activity among university students. *Mindfulness*, 4(3), 269-274. <https://doi.org/10.1007/s12671-012-0124-3>
- Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.
- Ogden, J., & Roy-Stanley, C. (2020). How do children make food choices? Using a think-aloud method to explore the role of internal and external factors on eating behaviour. *Appetite*, 147, 104551. <https://doi.org/10.1016/j.appet.2019.104551>
- O'Reilly, G. A., Cook, L., Spruijt-Metz, D., & Black, D. S. (2014) Mindfulness-based interventions for obesity-related eating behaviours: a literature review. *Obesity Reviews*, 15(6), 453-461. <https://doi.org/10.1111/obr.12156>
- Paterson, H., Hay-Smith, J., Treharne, G., Herbison, P., & Howarth, C. (2018). Validation of the Intuitive Eating Scale in pregnancy. *Journal of Health Psychology*, 23(5), 701-709. <https://doi.org/10.1177/1359105316671186>
- Peitz, D., Schulze, J., & Warschburger, P. (2021). Getting a deeper understanding of mindfulness in the context of eating behavior: development and validation of the Mindful Eating Inventory. *Appetite*, 159, 105039. <https://doi.org/10.1016/j.appet.2020.105039>
- Robinson, E., Kersbergen, I., & Higgs, S. (2014). Eating 'attentively' reduces later energy consumption in overweight and obese females. *British Journal of Nutrition*, 112(4), 657-661. <https://doi.org/10.1017/S000711451400141X>
- Román, N., & Urbán, R. (2019). Mindful awareness or self-regulation in eating: an

- investigation into the underlying dimensions of mindful eating. *Mindfulness*, *10*, 2110-2020. <https://doi.org/10.1007/s12671-019-01170-2>
- Sala, M., & Levinson, C. A. (2017). A longitudinal study on the association between facets of mindfulness and disinhibited eating. *Mindfulness*, *8*(4), 893-902. <https://doi.org/10.1007/s12671-016-0663-0>
- Shapiro, S. L., Carlson, L. E., Astin, J. A., & Freedman, B. (2010). Mechanisms of mindfulness. *Journal of Clinical Psychology*, *62*(3), 373-386. <https://doi.org/10.1002/jclp.20237>
- Rosseel, Y. (2012). Lavvan: an R package for structural equation modeling. *Journal of Statistical Software*, *48*(2). <https://doi.org/10.18637/jss.v048.i02>
- Tabachnick, B. G., & Fidell, L. S. (2018). *Using Multivariate Statistics* (7th ed). Pearson.
- Tonkin, E., Jeffs, L., Wycherley, T. P. Maher, C., Smith, R., Hart, J., Cubillo, B., & Brimblecombe, J. (2017). A smartphone app to reduce sugar-sweetened beverage consumption among young adults in Australian remote indigenous communities: design, formative evaluation and user-testing. *JMIR mHealth and uHealth*, *5*(12), e192. <https://doi.org/10.2196/mhealth.8651>
- Tourangeau, R., Rips, L. J., & Rasinski, K. (2000). *The psychology of survey response*. Cambridge: Cambridge University Press.
- Tronieri, J. S., Wadden, T. A., Pearl, R. L., Berkowitz, R. I., Alamuddin, N., & Chao, A. M. (2020). Mindful eating, general mindful awareness, and acceptance as predictors of weight loss. *Mindfulness*, *11*, 2818-2827. <https://doi.org/10.1007/s12671-020-01493-5>
- Tylka, T. L. (2006). Development and psychometric evaluation of a measure of intuitive eating. *Journal of Counseling Psychology*, *53*(2), 226-240. <https://doi.org/10.1037/0022-0167.53.2.226>
- Van Oort, L., Schröder, C., & French, D. (2011). What do people think about when they answer the Brief Illness Perception Questionnaire? A 'think-aloud' study. *British journal of health psychology*, *16*(2), 231-245. <https://doi.org/10.1348/135910710X500819>

- Van Strien, T., Frijters, J. E., Bergers, G., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders*, 5(2), 295-315. [https://doi.org/10.1002/1098-108X\(198602\)5:2<295::AID-EAT2260050209>3.0.CO;2-T](https://doi.org/10.1002/1098-108X(198602)5:2<295::AID-EAT2260050209>3.0.CO;2-T)
- Wang, M., Xu, S., Liu, W., Zhang, C., Zhang, X., Wang, L., Liu, J., Zhu, Z., Hu, J., Luo, X., & Wang, W. (2020). Prevalence and changes of BMI categories in China and related chronic diseases: cross-sectional National Health Service Surveys (NHSSs) from 2013 to 2018. *EClinicalMedicine*, 26, 100521. <https://doi.org/10.1016/j.eclinm.2020.100521>
- Warren, J. M., Smith, N., & Ashwell, M. (2017). A structured literature review on the role of mindfulness, mindful eating and intuitive eating in changing eating behaviours: effectiveness and associated potential mechanisms. *Nutrition research reviews*, 30(2), 272-283. <https://doi.org/10.1017/S0954422417000154>
- Williams, E. P., Mesidor, M., Winters, K., Dubbert, P. M., & Wyatt, S. B. (2015). Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. *Current Obesity Reports*, 4, 363-370. <https://doi.org/10.1007/s13679-015-0169-4>
- Winkens, L. H. H., van Strien, T., Barrada, J. R., Brouwer, I. A., Penninx, B. W. J. H., & Visser, M. (2018). The Mindful Eating Behavior Scale: Development and Psychometric Properties in a Sample of Dutch Adults Aged 55 Years and Older. *Journal of the Academy of Nutrition and Dietetics*, 118(7), 1277-1290. <https://doi.org/10.1016/j.jand.2018.01.015>
- Wu, S., Cai, T., & Luo, X. (2017). Validation of the Dutch Eating Behavior Questionnaire (DEBQ) in a sample of Chinese adolescents. *Psychology, Health, & Medicine*, 22(3), 282-288. <https://doi.org/10.1080/13548506.2016.1173712>
- Xu, W., Rodriguez, M. A., Zhang, & Liu, X. (2015) The mediating effect of self-acceptance in the relationship between mindfulness and peace of mind. *Mindfulness*, 6, 797-802.

Psychometric properties of the MEQ in Chinese samples

<https://doi.org/10.1007/s12671-014-0319-x>

Zhang, J., Wang, H. Wang, Z., Du, W., Su, C., Zhang, J., Jiang, H., Jia, X., Huang, F., Ouyang, Y., Wang, Y., & Zhang, B. (2018). Prevalence and stabilizing trends in overweight and obesity among children and adolescents in China, 2011-2015. *BMC Public Health*, 18, 571. <https://doi.org/10.1186/s12889-018-5483-9>

Table 1. Coding categories for analysis of think-aloud interviews

	Category	Description
1	No problem	No significant problems identified.
2	No sufficient thinking aloud	Participants did not report sufficient information for coding purposes on any of the four cognitive processes (Tourangeau, 1985).
3	Reread/stumbled	Participants re-read a question or stumbled whilst reading it. Although re-reading a question did not necessarily mean that participants had problems in understanding the question, more than one participant re-reading a question could indicate this question requires efforts to understand.
4	Problems understanding	Participants demonstrated problems in understanding or answering the question, including querying the meaning of the question, claiming they needed more information before they could answer it, or stated they were uncertain about whether they had understood or answered the question properly.
5	Misinterpretation	Participants appeared to answer a different question from the one that was asked, or gave reasoning that appeared inconsistent with, or irrelevant to, the answer given.

Table 2. Frequency and type of problems with the MEQ reported by Chinese adults (n = 7)

Construct (number of items)	N problematic items on subscale	N(%) of problems overall	Reread/ stumble d	Problems understan- ding	Misinter- - pretation
Awareness (7)	4	9 (20.9%)	—	3	6
Distraction (3)	2	2 (4.7%)	—	1	1
Disinhibition (8)	4	5 (11.6%)	—	1	4
Emotional response (4)	1	1 (2.3%)	—	1	—
External cues (6)	6	26 (60.5%)	2	4	20
Total (28)	17	43	2	10	31

Table 3. Frequency and type of problems with the MEQ reported by Chinese adolescents (n = 10)

Construct (number of items)	N problematic items on subscale	N of problems overall	Reread/ stumbled	Problems under- standing	Misinter- - pretation
Awareness (7)	5	18 (26.5%)	—	3	15
Distraction (3)	2	3 (4.4%)	1	—	2
Disinhibition (8)	3	6 (8.8%)	1	1	4
Emotional response (4)	—	—	—	—	—
External cues (6)	6	41 (60.3%)	4	4	33
Total (28)	16	68	6	8	54

Table 4. Examples of suggested rephrasing of awareness-related questions in the MEQ

Original content	Suggested rephrasing
<i>Awareness</i>	
10. I notice when there are subtle flavours in the foods that I eat.	I deliberately notice the subtle flavours in the foods that I eat.
12. When eating a pleasant meal, I notice if it makes me feel relaxed.	When eating a pleasant meal, I deliberately notice how it affects my bodily sensations.
16. I appreciate the way my food looks on my plate.	Before I eat, I take a moment to appreciate the way my food looks on my plate.
26. I notice when the food I eat affects my emotional state.	When I'm eating, I deliberately notice how the food I eat affects my emotional state.
<i>External cues</i>	
3. At a party where there is a lot of good food, I notice when it makes me want to eat more food than I should.	When there is a lot of good food around, I pay attention to how it might affect my desire to eat.
4. I recognise when food advertisements make me want to eat.	When watching food advertisements, I deliberately notice how it affects my desire to eat.
8. I notice when just going into a movie theatre makes me want to eat candy or popcorn.	When going into a movie theatre, I deliberately notice whether it makes me want to eat sweets or popcorn.
14. When I eat a big meal, I notice if it makes me feel heavy or sluggish.	When I eat a big meal, I deliberately notice how it might affect my bodily sensations.
23. I recognise when I'm eating and not hungry.	I recognise when I'm eating even though I'm not hungry.
24. I notice when I'm eating from a dish of candy just because it's there.	I deliberately notice whether I'm eating snacks just because they're there.

Psychometric properties of the MEQ in Chinese samples

Table 5. Confirmatory factor analysis and exploratory structural equation models fit indices

Model	WLSMV χ^2 (df)	CFI	TLI	RMSEA	90% CI	SRMR
C-MEQ CFA (5-factor)	361.37 (118.18)	.627	.728	.069	.064 - .075	.072
C-MEQ ESEM (5-factor)	161.32 (115.21)	.929	.947	.031	.019 - .040	.034
C-MEQ-R CFA (5-factor)	382.77 (112.98)	.587	.731	.075	.069 - .080	.073
C-MEQ-R ESEM (5-factor)	175.29 (114.86)	.908	.941	.035	.025 - .045	.035
C-MEQ-R ESEM (4-factor)	203.82 (117.81)	.868	.918	.041	.033 - .050	.040

Note. CFA = Confirmatory Factor Analysis; ESEM = Exploratory Structural Equation Model; WLSMV = Weighted Least Squares Means and Variance Adjusted; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual

Psychometric properties of the MEQ in Chinese samples

Table 6. Factor loadings for the 5-factor ESEM model of the C-MEQ-R

Item	Subscale of the original MEQ	Intentional Awareness	Dis-inhibition	Attentive Eating	Emotional Response	Dis-traction
R12. When eating a pleasant meal, I deliberately notice how it affects my bodily sensations.	Awareness	.66	.08	-.13	-.07	-.07
R4. When watching food advertisements, I deliberately notice how it affects my desire to eat.	External cues	.54	-.08	-.02	.02	-.07
R26. When I'm eating, I deliberately notice how the food I eat affects my emotional state.	Awareness	.51	.04	.02	-.18	-.09
R14. When I eat a big meal, I deliberately notice how it might affect my bodily sensations.	External cues	.43	-.12	.11	-.04	.17
R3. When there is a lot of good food around, I pay attention to how it might affect my desire to eat.	External cues	.42	.04	.10	-.13	.01
R8. When going into a movie theatre, I deliberately notice whether it makes me want to eat sweets or popcorn.	External cues	.38	-.08	-.00	.10	-.21
R24. I deliberately notice whether I'm eating snacks just because they're there.	External cues	.38	.08	.08	-.16	-.12
11. If there're leftovers that I like, I take a second helping even though I'm full.	Disinhibition	.07	.67	-.07	.12	.02
15. I stop eating when I'm full even when eating something I love.	Disinhibition	.04	.52	.24	.03	-.16
18. If there's good food at a party, I'll continue eating even after I'm full.	Disinhibition	-.09	.53	.10	.17	.11
5. When a restaurant portion is too large, I stop eating when I'm full.	Disinhibition	-.10	.42	.20	-.03	.05
7. When I'm eating one of my favourite foods, I don't recognise when I've	Disinhibition	-.01	.40	-.10	-.03	.19

Psychometric properties of the MEQ in Chinese samples

had enough.						
9. If it doesn't cost much more, I get the larger size food or drink regardless of how hungry I feel.	Disinhibition	-.11	.39	-.06	-.02	.13
2. When I eat at "all you can eat" buffets, I tend to overeat.	Disinhibition	-.17	.35	.02	-.05	.19
21. Before I eat I take a moment to appreciate the colours and smells of my food.	Awareness	.17	-.01	.47	-.08	-.09
R10. I deliberately notice the subtle flavours in the foods that I eat.	Awareness	.30	-.04	.39	.05	.11
R16. Before I eat, I take a moment to appreciate the way my food looks on my plate.	Awareness	.22	-.01	.38	-.02	-.01
20. I notice when foods and drinks are too sweet.	Awareness	-.07	-.02	.38	.05	.21
25. When I'm at a restaurant, I can tell when the portion I've been served is too large for me.	Disinhibition	.14	.05	.37	.11	.09
R23. I recognise when I'm eating even though I'm not hungry.	External cues	.12	-.04	.35	.03	.29
22. I taste every bite of food that I eat.	Awareness	.25	.02	.30	-.09	.03
19. When I'm sad, I eat to feel better.	Emotional response	.04	.01	.24	.81	-.03
17. When I'm feeling stressed at school/work, I'll go find something to eat.	Emotional response	-.06	.13	-.05	.49	.09
13. I snack without noticing that I'm eating.	Emotional response	-.16	.08	.04	.12	.49
6. My thoughts tend to wander while I'm eating.	Distraction	.13	.01	-.28	.10	.40
1. I eat so quickly that I don't taste what I eat.	Distraction	.07	.21	-.03	-.16	.28
27. I have trouble not eating ice cream, biscuits, or crisps if they're around the house.	Emotional response	-.13	.18	.02	.20	.12
28. I think about things I need to do while I'm eating.	Distraction	.00	.20	-.14	-.13	.13
Cronbach's α		.71	.70	.69	.64	.34

Note. Loadings > |.30| are in bold

Table 7. C-MEQ-R domains: descriptive statistics and intercorrelations (n =430)

Domain	Range	Mean	SD	IA	DI	AE	ER	DT
IA	1 – 4	2.28	.51	-				
DIS	1 – 4	2.74	.56	-.25***	-			
AE	1.14 – 4	2.40	.51	.39***	.05	-		
ER	1 – 4	2.71	.84	-.34***	.29***	-.14**	-	
DT	1-4	3.12	.70	-.22***	.29***	-.08	.23***	
<i>Summary score</i>	1.54 – 3.49	2.66	.30	.08	.60***	.36***	.61***	.60***

Note. ** $p < .01$; *** $p < .001$. IA: Intentional Awareness; DI: Disinhibition; AE: Attentive Eating; ER: Emotional Response; DT: Distraction

Table 8. Pearson correlation coefficients showing the relations between the scores on the C-MEQ-R, the C-MER and measures on mindfulness and eating behaviours (n = 430)

	C-MEQ-R						C-MEQ
	IA	DIS	AE	ER	MLE	Summary score	
FFMQ	.23***	.17***	.32***	.01	.14**	.32***	.25***
Observing	.39***	-.06	.57***	-.19***	.01	.25***	.31***
Describing	.26***	.08	.27***	.02	.02	.27***	.19**
Actaware	-.17***	.27***	-.07	.14**	.31***	.12*	.10*
Non-judging	-.24***	.11*	-.38***	.11*	.04	-.13**	-.22***
Non-reactivity	.29***	-.06	.32***	-.07	-.17***	.18***	.16**
DEBQ							
Emotional eating	.37***	-.29***	.04	-.55***	-.30***	-.42***	-.26***
External eating	.29***	-.36***	.20***	-.38***	-.20***	-.27***	-.09
BMI	-.10*	-.06	-.10*	.01	-.02	-.09*	-.06

Note. * $p < .05$; ** $p < .01$ *** $p < .001$; FFMQ: Five Facet Mindfulness Questionnaire; *Actaware*: acting with awareness; DEBQ: Dutch Eating Behavior Questionnaire