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ORIGINAL ARTICLE

Implicit and explicit anti-fat bias among Asian females

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Abstract Obesity is not only associated with an increased risk of numerous health problems, but also with high rates of stigmatization and weight-related bias. Anti-fat attitudes have been shown to be prevalent in Western samples; however, there is a lack of studies investigating both implicit and explicit anti-fat bias in Asian populations. There is also limited research investigating the relationship between anti-fat attitudes and weight-related behavioral intentions. Thus, this study aimed to examine anti-fat bias and its effect on behavioral intentions using three types of measures—implicit, explicit, and a revised behavioral intention measure—in a sample of 104 Asian females in Singapore. Significant differences were found between implicit and explicit bias: on average, participants exhibited strong implicit but no explicit anti-fat bias ($p < 0.001$). Furthermore, only implicit anti-fat bias was found to be a significant predictor of behavioral intentions ($p < 0.05$), after accounting for body mass index, and sociodemographic variables. In conclusion, the present study revealed that implicit anti-fat bias is present among Asian females and is a valid predictor of weight-related behavioral intentions. However, anti-fat bias is often not expressed explicitly, possibly influenced by collectivistic beliefs. More studies are needed to better understand similarities and differences between Asian and Western populations regarding attitudes toward overweight and obese individuals.

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Introduction

Obesity is associated with serious health consequences [50]. Beyond physical health problems, obesity is also often accompanied by social consequences of pervasive stigmatization, termed anti-fat bias [28]. Anti-fat bias refers to the negative stigmatization and generalization that overweight and obese individuals are perceived as lacking self-control and self-responsibility due to their excessive body weight [24, 46]. For instance, overweight people tend to be rated negatively across several domains, such as being less attractive, less healthy, but also less likeable, motivated, self-disciplined, and having less willpower as compared to their average-weight and underweight counterparts [1]. Recent findings show that weight-related stigmatization extends to perceived capabilities of overweight individuals, such as their lack of personal responsibility [27] or intelligence [41]. Overweight and obese individuals even hold similarly strong anti-fat attitudes toward their own in-group members (i.e., overweight and obese individuals) internalizing this bias [33, 46], thus ensuing low self-esteem and confidence levels. A recent study by Durso et al. [8] examined levels of internalized anti-fat bias in a sample of treatment-seeking overweight adults and found that the bias may be associated with one's perceived sense of consequences of being overweight rather than one's degree of overweight. The study reported that anti-fat bias internalization was associated with poorer mental and physical health-related quality of life and predictive of one's body image concern, self-esteem, and depressive symptoms. There is also well-established

evidence of anti-fat bias and discrimination prevailing in areas of healthcare [29, 47], employment [25, 26], education [20, 26], the media [32, 45], and even among family and friends [28]. Anti-fat bias has also been reported in clinicians, health professionals, and even among obesity researchers [41]. Thus, it seems crucial to understand how anti-fat attitudes can affect one's actions or behaviors toward obese individuals.

It is pertinent to note that there are gender differences in the perception of the ideal body shape and weight. Studies examining body ideals in Western samples, consistently showed that females place a greater emphasis on a thin ideal body image in comparison to males, whereas the male ideal body image not only includes the desire for less body fat, but also the pursuit for muscularity (e.g., [44]). Such gender differences in body image could lead to differential anti-fat attitudes between males and females [21]. A recent study by Flint et al. [11] reported that males demonstrated greater levels of anti-fat bias in a sample of UK adults possibly due to differing empathy. Also Puhl et al. [27] reported that women are more vulnerable to body weight-related stereotypes and negative stigma. Hence, it seems reasonable to investigate anti-fat attitudes separately for males and females. The present study will focus on examining anti-fat attitudes solely in females.

The rising prevalence and associated burden of obesity in Asian countries [30] calls for a closer investigation of anti-fat attitudes in Asian samples. Existing studies on Asian populations have reported significant levels of body dissatisfaction or preferences for a thin body across various Asian female populations, including Japanese women [19] and female university students [18], Taiwanese women [43] and female adolescents [48], and Chinese female university students both in China [31] and Hong Kong [6, 7]. While a number of studies have reported similar or greater levels of body dissatisfaction compared to female Western counterparts [7, 19, 43], other studies have found no differences among Western and non-Western cultures while controlling for socioeconomic status [35–38].

Previous studies conducted in urban cities in Malaysia, have found that individuals exhibited similar preferences for females with lower body mass index (BMI) [36, 37] and demonstrated greater body dissatisfaction similar to those in Western cultures rather than their counterparts from rural areas [38]. These trends may be accounted for by westernization and modernization among high-socioeconomic industrialized countries in Asia [35, 38], indicating a preference for thinness and potential of anti-fat attitudes. Higher socioeconomic status has been shown to be associated with, e.g., greater level of body dissatisfaction in Asian females [5, 17]. However, whether this is linked to stronger anti-fat attitudes remains unclear.

The island state Singapore, where the current study was conducted, offers an ideal setting to investigate these issues. Singapore (population approximately 5.5 million) comprises different local ethnic groups (Chinese, Malay, and Indian), but also a sizeable number of foreign national residents (Department of Statistics, Singapore). The socioeconomic standard of Singapore is high (e.g., high per capita income), and the population is highly educated and affluent [49]. Thus, in view of the existing literature, the level of anti-fat bias exhibited by Asian females in Singapore is hypothesized to be similar to that observed in Western samples. It would also be worthwhile to examine levels of anti-fat bias for Singaporeans vs. non-Singaporeans and across different ethnic groups.

Anti-fat bias has been assessed at both explicit and implicit levels. Explicit attitudes are operated by controlled processing, whereby individuals are consciously aware and able to control their responses [33]. They are often measured using direct self-report measures. This increases the chance of response bias, such as social desirability, as the intention of the measure is presented readily [15, 33, 34]. Thus, true attitudes may be concealed, as responses can be regulated [3, 15, 22, 33]. On the contrary, implicit attitudes are operated by automatic processing. They are unconscious and are activated by the mere presence of a target object without effort [23, 33]. These implicit attitudes are often internalized and endorsed as personal beliefs [45]. As implicit attitudes operate on an unconscious level, it is difficult to distinctively express them [33, 46]. Consequently, implicit measurements are less vulnerable to response bias; and therefore, offer a more accurate assessment tool as the likelihood of socially desirable responses is limited [12, 15, 33, 45, 46]. Implicit anti-fat bias is commonly assessed using timed performance-based measures; a prominent example is the implicit association test (IAT) [12]. The test is designed to conceal its true measuring purpose, and is more robust to changes and intentional influences [22].

Interestingly, implicit and explicit anti-fat biases have been found to operate independently from each other [3, 15, 34]. Even after controlling for potential confounding variables (i.e., social desirability or demand characteristics), both explicit and implicit anti-fat bias remain poorly correlated [4]. This implies that implicit anti-fat attitudes may not always be expressed readily and honestly [3, 15]. Despite the extensive literature conducted on investigating the relationship between implicit and explicit anti-fat bias, few studies have accounted for the difference in the relationship. In view of this, there is a need to further examine different types of anti-fat bias assessments to better understand differences between, e.g., explicit and implicit measures.

One of the main goals of studying prejudice and biased attitudes is to examine whether they (eventually) manifest

in discriminatory behavior. Discriminatory behavior is defined as the unfair treatment of a person based on underlying negative attitudes [2]. There are two types of attitude–behavior processes: spontaneous processing and deliberate processing. In spontaneous processing, one's behavior is unmindfully influenced by their own attitude, while conversely in deliberate processing, attitudinal influence is recognized [10]. Therefore, spontaneous and unconscious behaviors can be predicted by implicit attitudes, while deliberate and conscious ones can be predicted by explicit attitudes [10, 23]. Unfortunately, the attitude–behavior relationship is not easy to disentangle as there are numerous moderating factors involved. It has been found that explicit attitudes were not activated when the motivation to appear unbiased is low, as well as when time restrains are present [3, 10]. In such cases, implicit attitudes may be better in predicting both conscious and unconscious discriminatory behavior [3, 14].

According to the theory of planned behavior [2], attitudes are directly related to behavioral intentions, which in turn directly motivate individuals to behave in a certain way. Therefore, behavior may be accounted for by behavioral intentions and also subjective norms, and perceived behavioral control. However, few studies have examined anti-fat attitudes as a precursor to behavioral intentions, which could eventually lead to discriminatory behavior toward overweight and obese individuals [3, 14].

Findings from previous studies examining anti-fat attitudes in relation to discriminatory behavior lend support for a direct relationship; however, it remains unclear whether implicit or explicit anti-fat attitudes are better predictors of anti-fat discriminatory behavioral intention or actual behavior. In a study by Bessenoff and Sherman [3], implicit anti-fat bias was found to be positively correlated with unconscious non-verbal behaviors, such as sitting further away from a hypothetical obese woman. In contrast, other studies found that explicit anti-fat bias significantly predicted future hypothetical situations toward overweight targets (e.g., befriending, working on group class assignments) [4]. Similar to measuring explicit attitudes, social desirability should be considered when measuring discriminatory behavior in an unconcealed manner [22]. Hence, masking the true intent of an anti-fat behavioral intention measure would be warranted. Examining anti-fat bias and its relationship to anti-fat discriminatory behavior is pertinent to understanding weight prejudices and discrimination better. Given the aforementioned negative consequences of weight stigmatization for obese individuals' self-esteem and self-image, it is crucial to address issues of weight stigmatization.

Considering current evidence, this study hypothesized that Asian females in Singapore implicitly exhibit strong anti-fat bias compared to explicit measures, and that implicit anti-fat bias better predicts anti-fat behavioral intentions toward overweight and obese individuals.

Methods

Participants

An a priori power calculation was performed using GPower 3.1 [9], with $\alpha = 0.05$ and power $= 0.90$ to detect a small-to-medium effect size, Cohen's $f = 0.15$, to compute the required sample size, which was $n = 96$. Convenience sampling was used to recruit 140 Asian females aged above 18 years. All participants were students from a private university in Singapore. While calculating the implicit anti-fat measure, 36 participants had to be excluded due to high error rates on the IAT (for a detailed description, see Materials) resulting in a final sample of 104 participants. Participants who were omitted did not significantly differ (all $p > 0.05$) in terms of their BMI ($M = 21.3$, SD $= 3.7$), explicit (ATOP standardized score $M = -0.70$, SD $= 1.14$) and implicit anti-fat bias ($M = 1.15$, SD $= 0.96$) from the remaining 104 participants, whose data were used in the following analyses.

Participants' age ranged between 18 and 44 years ($M = 21.6$, SD $= 3.3$), with BMI ranging from 14.9 to 33.3 ($M = 21.4$, SD $= 3.9$). Using the World Health Organization's BMI classification, 22.1 % were considered underweight ($n = 23$), 64.4 % normal weight ($n = 67$), 8.7 % overweight ($n = 9$), and 4.8 % obese ($n = 5$). It should be noted that this reflects an under-representation of overweight and obese individuals in comparison to the National Health Survey 2010. A majority of the participants were Singaporeans ($n = 58$; 55.8 %), whereas the remaining included Malaysians ($n = 16$; 15.4 %), Indonesians ($n = 17$; 16.3 %), and others ($n = 13$; 12.5 %). Lastly, the ethnic breakdown was as follows: 70.2 % Chinese ($n = 73$), 16.3 % Indian ($n = 17$), 1.9 % Malay ($n = 2$), and 11.6 % others ($n = 12$).

Materials

Implicit association test (IAT)

The IAT is a widely used assessment tool first introduced by Greenwald et al. [12] to measure implicit attitudes. E-Prime 2.0 Professional (Psychology Software Tools, Inc.) was used to program the computerized version of the IAT assessing anti-fat bias [40]. The IAT is a timed word classification task that consists of three sets of 48-word items each, with the first being a practice set. Participants were required to classify word items, such as "obese",

"slim", "joyful", and "nasty", into either of the two superordinate categories which pair categories 'fat' with 'bad' and 'thin' with 'good', and vice versa. To classify the word items, participants were required to press either "A" or "L" on a standard computer keyboard, which, respectively, represented the superordinate categories that appeared on the left and right of the screen, on the keyboard. Individuals tend to classify items faster when the paired superordinate categories match (e.g., 'fat' and 'bad') than when they are mismatched (e.g., 'fat and thin') [12]. Presentation order of the sets was counterbalanced to minimize its influence. Every item's response latency and correct/incorrect classification were recorded to calculate the IAT difference (*D)* score. The IAT has been reported to have good internal consistency (average $\alpha = 0.80$) [23].

Adapting the methodology from Teachman and Brownell's [40] and Greenwald et al. [12], the algorithm D_6 [13] was used for data cleaning. Reaction time differences between matched and mismatched pairs in the IAT were calculated, and response times below 400 ms and above 10,000 ms were removed, as unusually slow and fast responding on the task may indicate inattention or lack of understanding [13]. Items that were matched incorrectly had their response times replaced by the sum of the mean of correct responses plus a 600 ms penalty. Participants with high error rates ($\geq$35 % incorrectly categorized items) were omitted due to unreliability [40]. This resulted in a total of 104 participants; although this is a high number of deletions, using a stringent criterion ensured data quality [40].

Attitudes toward obese persons (ATOP) scale

Participants' explicit anti-fat bias was measured with the ATOP scale which is a self-report questionnaire consisting of 20 statements measured on a 6-point Likert scale ranging from −3 (*I strongly disagree*) to +3 (*I strongly agree*). Some of the statements include "Obese people are as happy as nonobese people," and "Most obese people feel that they are not as good as other people". Higher scores indicate more positive attitudes toward overweight and obese persons, i.e., low explicit anti-fat bias. The ATOP possesses acceptable reliability and validity in adult populations [25] which is consistent with the current study (Cronbach's $\alpha = 0.71$).

Behavioral intentions toward overweight and obese individuals

Behavioral intentions toward overweight and obese individuals was operationalized as exclusionary acts in hypothetical situations, to account for a behavioral tendency driven by anti-fat bias. Adapted from a study by Swami et al. [39], a measure was developed to assess weight-related behavioral intentions, named behavioral intentions toward overweight and obese individuals. Three out of five hypothetical situations from Swami et al. [39] were adapted from a workplace to a college setting to enhance ecological validity for the current study's participants (i.e., university students), while the other two situations remained unchanged. The five hypothetical situations were mainly befriending someone new in college, working with a classmate for a group assignment, assignments' grades, parental ability, and helping a stranger. An example of an adapted scenario (i.e., assignments' grades) was: "Imagine you are a student at a university and the end of a semester is nearing. Your lecturer is returning all the grades for the assessments now. How likely do you think this person has done well for the assignment?".

Two grayscale photographic figures of real women in front-view were captured in identical poses and clothing at a standard distance. Faces were obscured to reduce influence of appearance-related factors (e.g., facial cues). The photographs each represented two BMI categories—normal weight (BMI = 18.5 to 24.9 kg/m^2) and obese (BMI $\geq$ 30.0 kg/m^2). Both female targets were presented with similar background information to minimize any confounding variables. For example, in the situation on assignments' grades, background information such as name, age, gender, race, and pre-college educational background were provided. Participants self-rated the perceived likelihood of behaving in a specific manner toward each female target in the hypothetical situations using a 5-point Likert scale ranging from 1 (*least likely*) to 5 (*most likely*). To minimize the presence of pro-thin bias while measuring anti-fat bias, a clean comparison between an overweight and an average-weight target was used instead of the original ten body figure comparisons. The presentation order of situations was randomized for every participant. Similar to the scoring system of Swami et al. [39], differences in ratings between the two female targets for each hypothetical situation was added to obtain a score for the behavioral intentions toward overweight and obese individuals. A score of 0 indicated neutral preference, while positive scores reflected greater anti-fat bias, and negative scores less bias. The internal consistency of the measure was satisfactory (Cronbach's $\alpha = 0.73$).

Procedure

Informed consent was first obtained from participants. The true aim of the study was masked from participants to minimize the influence of any confounding variables (e.g., response bias). Participants were then instructed to complete the three measurements in the following order: (1) behavioral intentions toward overweight and obese individuals questionnaire; (2) IAT; and (3) ATOP. The presentation order of the three measures was fixed to reduce demand characteristics.

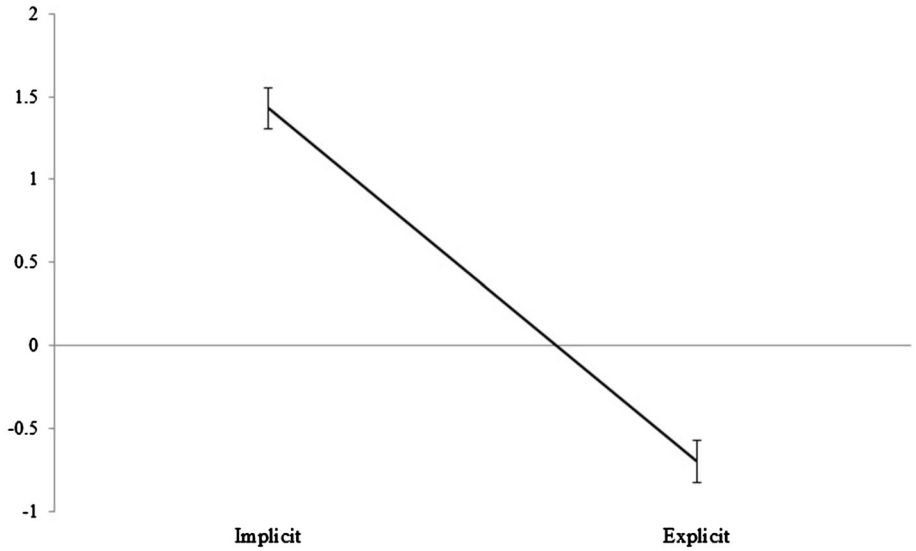

Fig. 1 Mean differences among implicit and explicit measures of anti-fat bias (including standard *error bars*)

Results

Prior to data analyses, the IAT scores were converted into difference (*D*) scores, using the above mentioned algorithm. The IAT *D*, ATOP, and behavioral intentions scores were then rescaled by dividing all scores by the standard deviation of the respective measure; both the IAT *D* and ATOP scores were then multiplied by -1 to convert the direction of measures [e.g., (ATOP score/SD) $\times -1$]. Thus, a score of 0 would be interpreted as the absence of anti-fat or pro-fat attitudes, a positive score would reflect anti-fat bias, whereas a negative score would indicate pro-fat attitudes across the two different attitudinal and the measure on behavioral intentions toward overweight and obese individuals. All analyses were performed using SPSS version 21.0 with a conventional α of 0.05.

A paired samples *t* test (two-tailed) was performed to compare mean reaction times (in milliseconds) between paired categories that matched their automatic attitudes ($M = 1163.39$, SD = 373.83) and mismatched ones ($M = 1610.53$, SD = 406.15). On average, participants reacted 447.14 ms faster (95 % confidence interval 386.36, 507.91) during matched paired categories than during mismatched ones, indicating an implicit anti-fat bias. This difference was statistically significant, $t(103) = 14.59$, $p < 0.001$, and large, Cohen's $d = 1.43$.

The relationship between the two measures of anti-fat bias was first investigated using Pearson product–moment correlation. There was no significant correlation between implicit and explicit anti-fat bias measures, $r = 0.18$, $n = 104$, $p = 0.065$. A paired samples *t* test (two-tailed) was then conducted to compare implicit (IAT *D* standardized scores: $M = 1.43$) and explicit anti-fat bias (standardized ATOP scores $M = -0.71$). On average, participants scored 2.15 standardized scores higher (95 % confidence interval: 1.90, 2.39) on the IAT compared to the ATOP measure. This difference was statistically significant, $t(103) = 17.11$, $p < 0.001$, and large, Cohen's $d = 1.68$. Figure 1 graphs the mean differences between the two anti-fat bias measurements (implicit and explicit) including standard error bars.

A hierarchical multiple regression was used to assess the two anti-fat bias measurements (implicit and explicit anti-fat bias) to predict the level of behavioral intentions toward overweight and obese individuals, after controlling for the influence of demographic variables including age, BMI, nationality (Singaporeans vs. non-Singaporean's), and ethnicity (Chinese vs. others)[1].The demographic variables were entered in Model 1, explaining 14.8 % of the variance in the level of behavioral intentions toward overweight and obese individuals. After entry of implicit and explicit anti-fat bias measurements in Model 2, the total variance explained by the model as a whole was 20.5 %, $F(6, 96) = 4.12$, $p = 0.001$. The two anti-fat bias measurements explained an additional 6 % of the variance in the level of behavioral intentions, after controlling for demographic variables, $\Delta R^2 = 0.06$, $\Delta F(2, 96) = 3.41$, $p = 0.037$. Results indicated that the level of implicit anti-fat bias was a significant predictor of behavioral intentions; average scores on the level of behavioral intentions increased by 0.24 standardized scores for each score increase on the IAT *D* (see Table 1).

Finally, a mixed between–within subjects analysis of variance was conducted to assess both the influence of nationality (Singaporeans, non-Singaporeans) and ethnicity (Chinese, others) across the two anti-fat bias

[1] Note that Indian ($n = 17$), Malay ($n = 2$), and other ethnicities ($n = 12$) were collapsed due to small sample sizes.

Table 1 Unstandardized (B) and standardized (β) regression coefficients and squared semi-partial correlations for each predictor variable predicting weight-related behavioral intentions ($N = 104$)

	B	[95 % CI]	β	sr^2
Model 1				
Age	−0.01	[−0.06, 0.05]	−0.02	−0.02
BMI	−0.07	[−0.12, −0.02]**	−0.28	−0.28
Nationality	0.51	[0.12, 0.89]*	0.25	0.24
Ethnicity	−0.15	[−0.56, 0.25]	−0.07	−0.07
Model 2				
Age	−0.01	[−0.07, 0.05]	−0.02	−0.02
BMI	−0.07	[−0.11, −0.02]**	−0.25	−0.24
Nationality	0.52	[0.13, 0.92]**	0.26	0.24
Ethnicity	−0.11	[−0.51, 0.29]	−0.05	−0.05
Explicit anti-fat bias	−0.01	[−0.21, 0.19]	−0.01	−0.01
Implicit anti-fat bias	0.24	[0.06, 0.43]*	0.24	0.24

CI confidence interval

* $p < 0.05$; ** $p < 0.01$

measurements. There was a significant interaction between nationality and the measurements, indicating that Singaporeans exhibited stronger pro-fat bias (i.e., less anti-fat bias) compared to non-Singaporeans, F (1, 100) = 7.43, $p = 0.008$, partial $\eta^2 = 0.07$. However, no significant interaction was found between ethnicity and the measurements, F (1, 100) = 3.02, $p = 0.085$. Table 2 shows the means and standard deviations of implicit and explicit anti-fat bias measurements between Singaporeans and non-Singaporeans, and Chinese and other ethnic groups.

Discussion

The current study yielded a strong implicit anti-fat bias among Asian females. These negative stigmatizing attitudes toward overweight and obese individuals are in line with findings from studies with Western samples [24, 28, 46]. However, a direct comparison of the current results and previous findings should be considered with caution due to differing methodologies (e.g., version of the IAT, algorithm to calculate the IAT score, etc.). Hence, absolute differences in levels of anti-fat bias between the current Asian sample and Western populations remain unclear. Future studies could investigate potential cultural differences in implicit anti-fat bias between Asian and Western samples.

A significant difference between the two types of anti-fat bias measures was found, suggesting that participants exhibited strong implicit anti-fat bias, but did not report this bias explicitly. This is consistent with previous research using Western samples which found strong implicit but weaker explicit anti-fat bias [15]. Interestingly, the current study found that, on average, participants explicitly expressed positive attitudes toward overweight and obese individuals which is in contrast to previous findings. This suggests that Asian females did not consciously reveal negative attitudes, but instead overtly expressed positive attitudes toward overweight and obese individuals. One possible explanation of this finding is that it might be socially unacceptable to overtly express negative attitudes toward overweight and obese individuals in Asian societies. Such cultural differences between Western and Asian communities might be explained by strong collectivistic characteristics embraced in Singapore [16]. Allocentrism, often associated with collectivism, emphasizes on being sensitive to the needs and emotions of others, thus giving priority to the collective self over the private self [42]. Considering that the majority of participants in this study were Singaporeans, a potential strong collectivistic view may have prevented them from disclosing anti-fat bias explicitly instead expressing positive attitudes to convey empathy and sensitivity toward an overweight and obese population.

The current findings also showed that implicit anti-fat bias predicted behavioral intentions toward overweight and obese individuals. Since behavioral intention is theorized to be a precursor to actual behavior, this finding may help to better understand the development of anti-fat discriminatory behaviors in Asian females. This is consistent with previous findings that implicit bias is predictive of spontaneous behavior [3]. A possible explanation for the present finding is the activation of implicit anti-fat attitudes due to the concealed purpose of measuring behavioral intentions. As participants were unaware of the true purpose of the behavioral intention measure, unconscious implicit anti-fat attitudes might have been activated leading to stronger associations with their behavioral intentions. It should be noted that it is possible that some participants may have guessed the purpose of the behavioral intention measure after rating normal-weight and obese female targets

Table 2 Means and standard deviations of implicit and explicit anti-fat bias measurements by nationality and ethnicity

	Singaporean ($n = 58$)	Non-Singaporean ($n = 46$)	Chinese ($n = 73$)	Others ($n = 12$)
Implicit anti-fat bias	1.46 (0.97)	1.39 (1.05)	1.49 (1.02)	1.29 (0.93)
Explicit anti-fat bias	−0.95 (1.00)	−0.42 (0.93)	−0.77 (0.97)	−0.60 (1.08)

repeatedly; it is also possible that this might have influenced participants' responses. However, assuming that some participants may have guessed the true purpose of the measure and responded in a biased manner (i.e., social desirability), the reported effect of implicit anti-fat bias predicting behavioral intention toward overweight and obese persons might be in fact an underestimation of the true effect (i.e., the predictive power of implicit anti-fat bias on behavioral intentions might be stronger). Future studies may include measures to assess the extent to which individuals perceive themselves to be aware of the measurement's purpose, to determine if the results are affected by demand characteristics (and potential exclusion of data).

Future research should aim to investigate individuals' actual behavior toward overweight and obese individuals. Anti-fat behavioral intentions do not necessarily lead to actual discriminatory behavior in real-world settings [22]. These anti-fat discriminatory behavior measures still require individuals' self-report, making them prone to social desirability and social norms [22]; e.g., anti-fat discriminatory behavior could be operationalized as social distance from an overweight and obese target, or helping behavior.

Participants, both Singaporeans and non-Singaporeans, reported positive and negative scores for the implicit and explicit measures, respectively. However, Singaporeans exhibited stronger implicit anti-fat bias, and weaker explicit anti-fat bias (i.e., stronger pro-fat bias) than their non-Singaporean counterparts. This insinuates that social desirability tendencies seem to be stronger among Singaporeans than non-Singaporeans. Despite the significant interaction effect between nationality and anti-fat measurements, this result should be interpreted with caution. Diverse culture, varying levels of socioeconomic status, as well as under-representation may account for the differences in the non-Singaporean sample. For example, nine other nationalities (e.g., Malaysian, Indonesian, Chinese and Indian, etc.) were included in the non-Singaporean sample. Moreover, the representation of each nationality group was not equal in size. No significant interaction effect was found for ethnicity and anti-fat measurements. Similarly, this may be due to an under-representation of some ethnicities. Hence, future research could focus on the effects of nationality and ethnicities in larger Asian samples.

Additionally, future research could focus on examining anti-fat bias toward males. Although, Swami and Tovée [36] reported that overweight men were rated more negatively in terms of attractiveness in neighboring Malaysia, research investigating gender differences in anti-fat attitudes is still largely lacking.

Interpretations of the current findings are limited due to the sampling strategy, whereby this study was conducted using students from a private university in Singapore. Thus, generalization to other Asian females is limited. For example, there was an under-representation of overweight and obese individuals in the current sample in comparison to the National Health Survey 2010. The following factors could have led to this bias: firstly, the ethnic breakdown of the current sample was not representative, especially considering the strong under-representation of Malays, who are reported to have the highest obesity rates in Singapore (24 %); secondly, as the current sample was recruited from a private university, both household incomes as well as educational levels are estimated to be above average which is negatively associated with obesity rates in Singapore. Another caveat of this study is the order in which the measures of anti-fat bias were administered. The previous anti-fat bias measure(s) may have affected participants' performance(s) on the subsequent measure(s).

In conclusion, implicit anti-fat bias toward overweight and obese individuals is widespread and strong in Asian females. However, due to the collectivistic nature of Asians, this bias is likely not expressed explicitly. Also, implicit anti-fat bias seems to be a valid predictor for weight-related discriminatory behavioral intentions, which could in turn lead to actual anti-fat discriminatory behavior.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest and nothing to disclose.

Ethical approval Before commencement of the study, ethical approval was granted from the Human Research Ethics Committee (HREC), James Cook University. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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