



## Original Research

# The Perceived Weight Stigma Scale and Weight Self-Stigma Questionnaire: Rasch analysis, confirmatory factor analysis, and network analysis among Chinese adolescents



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## ABSTRACT

**Objectives:** The objectives of the present study were to (i) re-evaluate and expand the psychometric properties of two weight stigma instruments—the Perceived Weight Stigma Scale (PWSS) and the Weight Self-Stigma Questionnaire (WSSQ) among a large sample of adolescents using advanced psychometric methods and (ii) examine how the different types of weight stigma (i.e., PWSS and WSSQ) are associated with psychological distress.

**Study design:** Cross-sectional study.

**Methods:** In September 2023, a cross-sectional survey utilising convenience sampling was used to recruit 9995 adolescents (mean age = 16.36 years [standard deviation = 0.78]; 57.8% males). They completed the PWSS, WSSQ, and a measure on psychological distress. The data were analysed using Rasch analysis, confirmatory factor analysis (CFA), structural equation modelling (SEM), and network analysis.

**Results:** The CFA and Rasch model results showed acceptable psychometric properties regarding factor structure, factor loading, difficulty, and infit and outfit mean squares (except Items 4 and 7 of the PWSS). There was no substantial differential item functioning for any tested items across the sex and weight categories. The CFA and SEM results showed promising validity indices with significant associations

## Introduction

The number of individuals with obesity or who are overweight is a significant public health issue globally, due to the pervasiveness of the condition and its associated physical and psychological health consequences over the past four decades.<sup>1-3</sup> This study focuses on weight stigma, a psychological-related health impact of overweight/obesity which is often less discussed and especially, among adolescents as they are in a unique period of development with long-lasting implications.<sup>4-6</sup> Several

studies have associated weight stigma with poor health outcomes (i.e., both physical and mental)<sup>7-13</sup> and psychological distress.<sup>12,14</sup>

The Perceived Weight Stigma Scale (PWSS) and Weight Self-Stigma Questionnaire (WSSQ) are both valid and reliable assessment tools used in numerous studies across different cultures and countries for examining different personal-levels of weight stigma.<sup>15-19</sup> However, no previous study has ever simultaneously assessed the differences between these two scales in assessing weight stigma among adolescents. This is novel and particularly important among adolescents because they are still undergoing different developmental processes (e.g., cognitive and physical) and it is unclear if these psychometric instruments can distinguish different types of weight stigma among this cohort. Examining the psychometric properties simultaneously helps to ascertain how effectively both scales assess weight stigma among adolescents. Therefore, the study addressed these research gaps using advanced psychometric testing methods (e.g., network analysis) among a large sample of adolescents. The objectives of the present study were to (i) re-evaluate the psychometric properties of two weight stigma questionnaires (i.e., PWSS and WSSQ) to examine if the PWSS and WSSQ assess different types of weight stigma, among a large sample of adolescents using advanced psychometric methods and, (ii) examine how different types of weight stigma (assessed by PWSS and WSSQ) are associated with psychological distress.

## **Methods**

### ***Participants and procedures***

In September 2023, a cross-sectional survey utilizing a convenience sampling strategy was used to recruit 9,995 students from three vocational secondary schools and three

vocational high schools in a southern province of China. The researchers sent an invitation letter to four vocational secondary schools and four vocational high schools, all of which had previously collaborated with the research team. Three secondary schools and three high schools agreed to participate in the study. The researchers provided information about the study to both the students and their parents. Those who were interested in the study and voluntarily agreed to participate completed the measures.<sup>20,21</sup> More specifically, an online informational session was organized for the parents of students in the participating schools before the commencement of data collection. This session disseminated information about the survey's content and informed parents and their children about their rights, such as the freedom to opt out of participation at any stage, even after initially agreeing, or the option to not complete the survey. Following the session, links to an online consent form were distributed to all parents. For those who consented, their children were allowed to participate in the survey during their information technology (IT) classes. The students who consented to participate completed the online survey in computer labs under the supervision of their IT instructors. The study was approved by the Human Subjects Ethics Review Board of the XXXX (--blinded for review--) XXXX.

## ***Measures***

### *Demographic information*

The participants provided their demographic information including age, sex, height, weight, school type (vocational secondary or vocational high), grade, number of siblings, and department (e.g., management, economics). Body mass index (BMI) was also calculated for each participant taking into consideration their age and sex.

*Perceived Weight Stigma Scale (PWSS; see Supplementary material A for all items)*

The PWSS is a 10-item scale used to assess an individual's level of perceived weight stigma. All items are rated either 'Yes' (1) or 'No' (0), which are summed to get a total score ranging between 0 and 10. A higher score indicates a higher level of perceived weight stigma. The PWSS has acceptable psychometric properties<sup>18</sup> including its Chinese version<sup>22,23</sup> and among adolescents.<sup>24</sup>

*Weight Self-Stigma Questionnaire (WSSQ; see Supplementary material B for all items)*

The WSSQ is 12-item scale for assessing weight-related self-stigma. The scale comprises two domains (WSSQ-F1: self-devaluation; WSSQ-F2: fear of enacted stigma) each with six items. All of the 12 items are rated on a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The responses to each item are added to generate two domain scores ranging from 6 to 30. A higher total score indicates a greater level of self-devaluation and fear of enacted stigma, and overall weight-related self-stigma. The WSSQ has satisfactory psychometric properties<sup>25-27</sup> including its Chinese version<sup>17,28</sup> and among adolescents.<sup>17,26</sup>

*Depression, Anxiety, and Stress Scale-21 (DASS-21)*

The DASS-21 is 21-item scale that assesses three types of psychological distress<sup>29</sup>: depression (seven items), anxiety (seven items), and stress (seven items). All of the items are rated on a four-point Likert scale from 0 (*did not apply to me at all, never*) to 3 (*applied to me very much, or most of the time, almost always*). The responses to each item are added to generate a total score for the full scale (ranging from 0 to 63), or each subscale (ranging from 0 to 21) with a higher score indicating a greater level of

psychological distress (full scale).<sup>29</sup> The DASS-21 has acceptable psychometric properties<sup>29,30</sup> including its Chinese version<sup>31-34</sup> and among adolescents.<sup>32,35</sup>

### *Data analysis*

The participants' demographics were first analysed using descriptive statistics (e.g., means and frequencies). A one-way analysis of variance (ANOVA) was used to compare the different weight groups. Then, three measures (i.e., PWSS, WSSQ, and DASS-21) were analysed using Pearson's correlations. The psychometric testing of the PWSS and WSSQ was performed using Rasch analysis, confirmatory factor analysis (CFA) with structural equation modelling (SEM), and network analysis.

For the Rasch analysis, a partial credit model was used.<sup>36</sup> Two item properties were evaluated using Rasch analysis: fit statistics using mean square (MnSq, with a value between 0.5 and 1.5 indicating a good fit),<sup>37</sup> and differential item functioning (DIF, across sex and weight status) using DIF contrasts (absolute value smaller than 0.5 indicates it being DIF-free).<sup>38</sup> All PWSS and WSSQ items were calculated for their difficulties in their embedded concept and illustrated using a Wright map and a person-item map.

For the CFA and SEM, a diagonally weighted least squares estimator was used.<sup>39</sup> Three CFA models and four SEM models were constructed. The following indices were used for the data-model fit tests in the CFA and SEM: a comparative fit index (CFI) > 0.95, a non-normed fit index (NNFI) > 0.95, a root mean square error of approximation (RMSEA) < 0.08, and a standardized root mean square residual (SRMR) < 0.08.<sup>40,41</sup> For the network analysis, an estimator of extended Bayesian information criterion

(EBICglasso) was used with 1000 bootstrapping resamples.<sup>42</sup> Network analysis was used to provide visualized associations between the studied items (i.e., PWSS and WSSQ items in the present study). Items that were associated strongly together were clustered to illustrate the pattern of a construct when different scales (or factors) were analysed using network analysis.<sup>43</sup>

## **Results**

The participants were adolescents with a mean age of 16.36 years (SD=0.78). Most of the participants had obesity issues (41.9%) followed by those with normal weight (40.2%), overweight (10.7%), and underweight (7.2%). Over half the participants were males (57.8%), two-thirds had siblings (66.8%), and over half were in a vocational high school (53.3%). Further details can be found in Table 1. A comparative analysis (one-way ANOVA) across the four weight groups showed significant between-group differences in PWSS, WSSQ, and DASS scores. For instance, participants in the underweight group had significantly higher PWSS and DASS scores than participants in the normal group. Participants in the overweight group had significantly higher WSSQ scores than those in the obesity group, and those in the obesity group had significantly higher WSSQ scores than those in the normal and underweight groups (see Supplementary Table S1). Table 2 shows the correlation results were significant, with positive relationships between weight self-stigma, perceived weight stigma, psychological distress, and its sub-scales; anxiety, depression, and stress, with the correlation coefficients between  $r=0.23$  and  $r=0.97$  (all  $p$ -values $<0.01$ ).

[Insert Tables 1 and 2 here]

The Rasch analysis in Table 3 shows that the PWSS with item difficulty ranged between -0.79 and 1.08, had satisfactory psychometric properties in terms of infit MnSq (values between 0.77 and 1.06), and was DIF-free across sex (values between -0.18 and 0.49) and weight status subgroups (DIF contrasts between -0.19 and 0.18 for overweight-normal; -0.21 and 0.19 for obesity-normal; and -0.31 and 0.31 for underweight-normal). However, outfit MnSq showed that two PWSS items were redundant (i.e., Item 4 with outfit MnSq of 0.39; and Item 7 with outfit MnSq of 0.49) with all the other items ranging within 0.5 and 1.5.

Moreover, the WSSQ-F1 with item difficulty ranging between -0.36 and 0.67 had satisfactory psychometric properties in terms of infit MnSq (values between 0.74 and 1.45), outfit MnSq (values between 0.73 and 1.45) and being DIF-free across sex (values between -0.30 and 0.32 across sex) and weight status subgroups (DIF contrasts between -0.36 and 0.31 for overweight-normal; -0.10 and 0.15 for obesity-normal; and -0.21 and 0.21 for underweight-normal). Furthermore, the WSSQ-F2 with item difficulty ranging between -0.85 and 0.33 had satisfactory psychometric properties in terms of infit MnSq (values between 0.55 and 1.42), outfit MnSq (values between 0.53 and 1.39), and being DIF-free across sex (values between -0.25 and 0.37) and weight status subgroups (DIF contrasts between -0.30 and 0.27 for overweight-normal; -0.33 and 0.35 for obesity-normal; and -0.23 and 0.22 for underweight-normal).

The CFA factor loadings for PWSS (0.63-0.78), WSSQ-F1 (0.71-0.90), and WSSQ-F2 (0.86-0.93) were all above 0.5. Finally, the Wright Person-Item Map (see supplementary Figures 1 and 2) indicated that the majority of participants possessed low levels of traits in perceived weight-stigma and weight self-stigma with mean person

measures ranging between 0.24-6.59 for PWSS, and -7.19-6.68 for WSSQ (see Supplementary Figures 3 and 4).

[Insert Table 3]

The CFA results in Table 4 show acceptable fit indices for the one-factor PWSS (CFI = 0.996, NNFI = 0.994, RMSEA = 0.022, and SRMR = 0.031) and two-factor WSSQ (CFI = 0.999, NNFI = 0.998, RMSEA = 0.025, and SRMR = 0.025). Moreover, the CFA for the two combined stigma scales reported acceptable fit indices (CFI = 0.997, NNFI = 0.997, RMSEA = 0.019, and SRMR = 0.026). Additionally, the SEM analysis showed acceptable concurrent validity for the two stigma scales with psychological distress (CFI = 0.997, NNFI = 0.997, RMSEA = 0.019, and SRMR = 0.026), depression (CFI = 0.997, NNFI = 0.997, RMSEA = 0.017, and SRMR = 0.025), anxiety (CFI = 0.997, NNFI = 0.996, RMSEA = 0.020, and SRMR = 0.026), and stress (CFI = 0.997, NNFI = 0.997, RMSEA = 0.018, and SRMR = 0.025).

In the SEM analysis, the latent correlations were 0.33 between PWSS and psychological distress (Supplementary Figure 5); 0.35 between PWSS and depression (Supplementary Figure 6); 0.33 between PWSS and anxiety (Supplementary Figure 7); and 0.32 between PWSS and stress (Supplementary Figure 8). The latent correlations were 0.23 between WSSQ-F1 and psychological distress; 0.22 between WSSQ-F1 and depression; 0.21 between WSSQ-F1 and anxiety; and 0.26 between WSSQ-F1 and stress. The latent correlations were 0.17 between WSSQ-F2 and psychological distress; 0.17 between WSSQ-F2 and depression; 0.19 between WSSQ-F2 and anxiety; and 0.14 between WSSQ-F2 and stress.

[Insert Table 4 here]

The network analysis of the cross-sectional survey in Figure 1 shows that within the PWSS, nodes PWSS1 and PWSS2 ( $r=0.55$ ), PWSS4 and PWSS5 ( $r=0.56$ ), and PWSS9 and PWSS10 ( $r=0.32$ ) had the strongest edge intensity. Within the WSSQ-F1, nodes WSSQS2 and WSSQS3 ( $r=0.46$ ) had the strongest edge intensity, while within the WSSQ-F2, nodes WSSQF8 and WSSQF12 ( $r=0.38$ ), WSSQF10 and WSSQF11 ( $r=0.36$ ), WSSQF11 and WSSQF12 ( $r=0.44$ ) had the strongest edge intensity. For inter-variable connectivity (PWSS and WSSQ), the most notable link was between nodes PWSS3 and WSSQF7 ( $r=-0.18$ ).

[Insert Figure 1 here]

## **Discussion**

The present cross-sectional study examined the psychometric properties of PWSS and WSSQ among a large sample of Chinese adolescents (in vocational schools) and its association with psychological distress using advanced psychometric methods (including network analysis which has never been used to evaluate the properties of either scale). Participants who were underweight had significantly higher perceived weight stigma and psychological distress compared to participants within the normal weight indicating that adolescents who are underweight also experience significant weight and psychological challenges. However, it seems individuals who are overweight or had obesity had significantly higher weight self-stigma compared to the other groups. This indicates that those who are overweight or who have obesity are

more affected by weight self-stigma. Additionally, correlational analyses showed a significant and positive association between weight stigma and psychological distress, with stronger associations between types of weight stigma and psychological distress compared to between the stigma scales themselves (i.e., PWSS and WSSQ—self-devaluation and fear of enacted stigma). This suggests that an individual reporting greater perceived weight stigma or weight self-stigma and higher psychological distress is more likely than an individual with greater perceived weight stigma to report higher weight self-stigma, respectively. The findings are supported by previous studies<sup>10,15-19,44</sup> showing that weight stigmas are related with psychological distress across different populations including adults,<sup>18,19</sup> university students,<sup>16</sup> and children/adolescents.<sup>15,17</sup>

On the whole, the results of the Rasch analysis indicated that the PWSS and WSSQ are suitable scales with acceptable psychometric properties to assess weight stigma.<sup>15</sup> The item difficulties (i.e., difficulty and infit-outfit MnSq) were well within the normal range for both PWSS and WSSQ (i.e., WSSQ-F1 and WSSQ-F2) indicating that the items are suitable to be used among adolescents except for Items 4 and 7 of PWSS, which had minor psychometric concerns. However, given that the CFA results on its factor loadings are acceptable (i.e., PWSS Items 4 and 7 are 0.78 and 0.74 respectively), it can be concluded that both these items contribute to the factor structure, and so may be retained. Also, the DIF between sexes and weights were all within the normal range indicating that there were no differences in what the items assess between males and females as well as adolescent weight status (overweight-normal, obesity-normal, and underweight-normal). This supports that the items of both weight stigma scales assess the same constructs among adolescents of different sexes and weights.<sup>15</sup> Moreover, the Wright Person-Item Map suggested that the majority of participants in the present study

possessed low levels of perceived weight stigma and weight self-stigma. This is partially evident in the mean scores of PWSS and WSSQ because both scores were below the possible average scores for each respective scale (i.e., 5 for PWSS and 30 for WSSQ). These findings suggest that both weight stigma scales can be used to assess weight stigma.

The CFA fits confirmed the unidimensionality of PWSS and for WSSQ-F1 and WSSQ-F2 (WSSQ has two subscales) as reported by previous studies.<sup>15,16,22</sup> Regarding validity, the SEM results showed a positive small-medium association between both weight stigma scales and psychological distress (i.e., depression, anxiety and/or stress), indicating the validity of weight stigma and the inherent harms associated with weight stigma. Moreover, this implies that both perceived weight stigma and weight self-stigma play a significant role in psychological distress. This strengthens the earlier assertion on the likelihood that weight stigma (either perceived or self-stigma) can lead to psychological distress (i.e., depression, anxiety and/or stress)<sup>8,10,12,16,18,44</sup> and other physical/psychological health consequences.<sup>8,10,11,13,44,45</sup>

The network analysis results indicated varied degrees (or strengths) of positive relationships between items within the PWSS. Although there seemed to be a few central nodes, they were not very distinct apart from the obvious inter-nodal relations. That is, there were obvious positive relationships between nodes (i.e., nodes 1 and 2, 4 and 5, and 9 and 10; see Appendix 1 for node's item details). This suggests the interdependence of the items, indicating that the PWSS items may be a single factor structure. Moreover, similar to the PWSS, the WSSQ-F1 had only one strongest edge. More specifically, nodes 2 (*"I caused my weight problems"*) and 3 (*"I feel guilty*

*because of my weight problems*”) were positively related to each other although the nodes were closely grouped. This suggests the WSSQ-F1 items may belong to the same factor structure. Comparatively, the WSSQ-F2 had several obvious inter-nodal relationships, although there was no obvious central node. That is, there were obvious positive relationships between nodes (i.e., nodes 8 and 12, 10 and 11, and 11 and 12; see Appendix 1 for node’s item details). The nodes relating to WSSQ-F2 seemed closely and positively related to each other despite no obvious central node suggesting how close the items are in representing a single factor structure. For inter-variable connectivity (PWSS and WSSQ), the most notable link was between nodes PWSS3 (“*People act as if they are afraid of you*”) and WSSQF7 (“*I feel insecure about others’ opinions of me*”). These results are important, especially the inter-variable connectivity (PWSS and WSSQ) because they indicate how and where PWSS and WSSQ link significantly to form a common weight stigma among adolescents. Therefore, the additional network analysis complemented the CFA results.<sup>46</sup>

### ***Limitations, strengths, and implications***

The present study has some limitations. Firstly, the study used a cross-sectional survey limits the interpretation of cause-effect associations between the weight stigma scales and psychological distress. Secondly, the non-probability (convenience) sampling strategy may limit the generalization of the findings to all adolescents in China, especially those in non-vocational schools. However, steps were taken to lessen the limitation of using a convenience sampling strategy (e.g., such as increased sample size, setting clear and simple objectives, and using validated scales).<sup>20,21</sup> Finally, the study only comprised adolescents in vocational schools in China. Future studies may consider

combining data from different countries and different schools to ascertain the collective psychometric properties and the effect of cultural differences on weight stigma.

Notwithstanding these limitations, there are several strengths to the present study. Firstly, the study used several robust forms of statistical analyses (e.g., Rasch analysis, CFA, SEM, and network analysis) to help obtain a comprehensive and novel psychometric understanding of the weight stigma scales (i.e., PWSS and WSSQ). Secondly, the study associated the items together using network analysis, which helped show how and where PWSS and WSSQ are specifically linked. Finally, showing the associations between weight stigma scales and psychological distress (i.e., depression, anxiety and stress) confirms and strengthens the need for more frequent (psycho)education among adolescents.

Consequently, the present study has several clinical and research implications in using the PWSS and WSSQ for assessing weight-related health issues such as psychological distress. Those who have weight stigma issues should be assessed for psychological distress or be assumed to have psychological distress if assessment cannot be done immediately. The PWSS and WSSQ assess different forms of weight stigma as depicted by their content. More specifically, the PWSS assesses weight stigma from another person's perspective or as observed. However, the WSSQ assesses weight stigma from a personal perspective (i.e., self-devaluation and fear of enacted stigma). Therefore, researchers and clinicians need to choose each scale for its respective purposes. Because both scales are valid and reliable, they can be used and interpreted across sexes and for those with and without weight issues. Furthermore, the average scores (i.e., 5 for PWSS and 15 each for WSSQ-Self-Devaluation and WSSQ-Fear of enacted stigma) can be

used as cut-off points in classifying those who have weight stigma issues. In a clinical setting, how each item is scored by clients on the respective scales should also be taken into consideration in formulating bespoke interventions. Health educators need to educate the public on the effects of being overweight and obesity, especially in relation to harmful stigma-related effects.<sup>9,44,45,47</sup>

## **Conclusion**

The present cross-sectional survey examined the robustness of the psychometric properties of the PWSS and WSSQ instruments among a large sample of Chinese adolescents. The results confirmed that both weight stigma scales have acceptable psychometric properties. This suggests that researchers and clinicians can use these scales to reliably and validly assess weight stigmas among Chinese adolescents. Moreover, weight stigma is associated with psychological distress (i.e., depression, anxiety and stress). Researchers, clinicians, and other healthcare professionals may, to a reasonable degree, be able to predict the associated psychological distress among adolescents who are found to have weight stigmas. Therefore, the results of the present study may encourage the use of these two assessment instruments for multiple purposes. Promoting awareness of the associations between weight stigma and psychological distress to community members (e.g., parents and families), researchers, clinicians, and other health and education experts may be beneficial in helping to reduce weight stigma and/or show the harmful consequences of weight stigma.

## **List of abbreviations**

PWSS: Perceived Weight Stigma Scale

WSSQ: Weight Self-Stigma Questionnaire

CFA: Confirmatory Factor Analysis

SEM: Structural Equation Modelling

CVD: cardiovascular diseases

IT: Information technology

MnSq: mean square

DIF: differential item functioning

CFI: comparative fit index

NNFI: non-normed fit index

RMSEA: root mean square error of approximation

SRMR: standardized root mean square residual

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Table 1. Participant characteristics (n=9,995)

|   | Mean (SD) or n (%) |               |               |
|---|--------------------|---------------|---------------|
|   | Entire sample      | Male sample   | Female sample |
| Age (in years)  | 16.36 (0.78)       | 16.34 (0.78)  | 16.38 (0.77)  |
| Height  | 169.86 (9.68)      | 176.33 (8.05) | 164.02 (7.63) |
| Weight  | 64.62 (15.33)      | 67.99 (13.90) | 60.79 (15.96) |
| Weight status   |                    |               |               |
| <i>Underweight</i>  | 721 (7.2%)         | 401 (6.9%)    | 320 (7.6%)    |
| <i>Normal</i>   | 4015 (40.2%)       | 2077 (35.9%)  | 1938 (46.0%)  |
| <i>Overweight</i>   | 1074 (10.7%)       | 711 (12.3%)   | 363 (8.6%)    |
| <i>Obesity</i>  | 4185 (41.9%)       | 2589 (44.8%)  | 1596 (37.8%)  |
| School type   |                    |               |               |
| <i>Vocational secondary school</i>  | 4667 (46.7%)       | 2817 (48.8%)  | 1850 (43.9%)  |
| <i>Vocational high school</i>   | 5328 (53.3%)       | 2961 (51.2%)  | 2367 (56.1%)  |
| Grade   |                    |               |               |
| <i>Vocational secondary school (Grade 1)</i>                              | 2476 (24.8%)       | 1575 (27.3%)  | 901 (21.4%)   |
| <i>Vocational secondary school (Grade 2)</i>                              | 2642 (26.4%)       | 1489 (25.8%)  | 1153 (27.3%)  |
| <i>Vocational high school (Grade 1)</i>                                   | 2152 (21.5%)       | 1215 (21.0%)  | 937 (22.2%)   |
| <i>Vocational high school (Grade 2)</i>                                   | 1667 (16.7%)       | 925 (16.0%)   | 742 (17.6%)   |
| <i>Vocational high school (Grade 3)</i>                                   | 1058 (10.6%)       | 574 (9.9%)    | 484 (11.5%)   |
| Sex   |                    |               |               |
| <i>Male</i>   | 5778 (57.8%)       | --            | --            |
| <i>Female</i>   | 4217 (42.2%)       | --            | --            |
| Siblings  |                    |               |               |
| <i>No</i>   | 3320 (33.2%)       | 2248 (38.9%)  | 1072 (25.4%)  |
| <i>Yes</i>  | 6675 (66.8%)       | 3530 (61.1%)  | 3145 (74.6%)  |
| Department  |                    |               |               |
| <i>Management</i>   | 458 (4.6%)         | 202 (3.5%)    | 256 (6.1%)    |
| <i>Economics</i>  | 1143 (11.4%)       | 301 (5.2%)    | 842 (20.0%)   |
| <i>Education</i>  | 601 (6.0%)         | 330 (5.7%)    | 271 (6.4%)    |
| <i>Engineering</i>  | 3024 (30.3%)       | 2451 (42.4%)  | 573 (13.6%)   |
| <i>Agriculture</i>  | 1108 (11.1%)       | 547 (9.5%)    | 561 (13.3%)   |
| <i>Science</i>  | 1195 (12.0%)       | 739 (12.8%)   | 456 (10.8%)   |
| <i>Arts</i>   | 867 (8.7%)         | 295 (5.1%)    | 572 (13.6%)   |
| <i>Medicine</i>   | 398 (4.0%)         | 142 (2.5%)    | 256 (6.1%)    |
| <i>Others (philosophy, law, history, military, and Interdisciplinary)</i> | 1201 (11.9%)       | 771 (13.3%)   | 430 (10.1%)   |

1

2 Table 2. Mean and the correlation among the observed variables

| Total participants ( $N=9,995$ ) | <i>Mean (SD)</i> | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> |
|----------------------------------|------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. PWSS                          | 1.39 (2.53)      | —        |          |          |          |          |          |          |          |
| 2. WSSQ-T                        | 25.92 (11.27)    | 0.25     | —        |          |          |          |          |          |          |
| 3. WSSQ-F1                       | 13.27 (5.69)     | 0.23     | 0.97     | —        |          |          |          |          |          |
| 4. WSSQ-F2                       | 12.64 (5.88)     | 0.26     | 0.97     | 0.90     | —        |          |          |          |          |
| 5. DASS-21-T                     | 12.27 (12.28)    | 0.41     | 0.47     | 0.45     | 0.46     | —        |          |          |          |
| 6. DASS-21-Depression            | 3.78 (4.31)      | 0.42     | 0.45     | 0.43     | 0.45     | 0.97     | —        |          |          |
| 7. DASS-21-Anxiety               | 4.09 (4.16)      | 0.39     | 0.46     | 0.44     | 0.45     | 0.97     | 0.91     | —        |          |
| 8. DASS-21-Stress                | 4.40 (4.23)      | 0.38     | 0.45     | 0.43     | 0.45     | 0.97     | 0.90     | 0.90     | —        |

3 All  $p$ -values<0.01

4 PWSS: Perceived Weight Stigma Scale

5 WSSQ-T: Weight Self-Stigma Questionnaire-Total

6 WSSQ-F1: WSSQ Factor 1 (Self-Devaluation)

7 WSSQ-F2: WSSQ Factor 2 (Fear of enacted stigma)

8 DASS-21-T: Psychological distress (i.e., Depression, Anxiety, and Stress Scale-21-Total)

9

Table 3. Psychometric properties of PWS and WSSQ on item level among vocational school students

|                 | Factor loadings <sup>a</sup> | Difficulty | INFIT MnSq | OUTFIT MnSq | DIF contrast <sup>b</sup> | DIF contrast <sup>c</sup> | DIF contrast <sup>d</sup> | DIF contrast <sup>e</sup> |
|-----------------|------------------------------|------------|------------|-------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>PWSS</b>     |                              |            |            |             |                           |                           |                           |                           |
| Item 1          | 0.76                         | 0.02       | 0.81       | 0.51        | 0.11                      | 0.08                      | 0.07                      | 0.05                      |
| Item 2          | 0.73                         | -0.02      | 0.88       | 0.71        | -0.18                     | -0.11                     | -0.11                     | -0.29                     |
| Item 3          | 0.64                         | 1.08       | 0.89       | 0.83        | 0.45                      | -0.09                     | -0.08                     | -0.21                     |
| Item 4          | 0.78                         | 0.15       | 0.77       | 0.39        | 0.25                      | -0.04                     | 0.13                      | 0.29                      |
| Item 5          | 0.77                         | 0.03       | 0.79       | 0.51        | 0.39                      | -0.07                     | 0.08                      | 0.23                      |
| Item 6          | 0.63                         | 0.11       | 1.05       | 1.04        | 0.10                      | 0.07                      | -0.14                     | -0.31                     |
| Item 7          | 0.74                         | 0.36       | 0.84       | 0.49        | 0.35                      | -0.19                     | -0.21                     | -0.22                     |
| Item 8          | 0.66                         | -0.79      | 1.02       | 1.00        | 0.18                      | 0.15                      | 0.02                      | 0.15                      |
| Item 9          | 0.66                         | -0.55      | 1.02       | 0.88        | -0.11                     | 0.03                      | 0.05                      | 0.31                      |
| Item 10         | 0.64                         | -0.39      | 1.06       | 1.08        | 0.49                      | 0.18                      | 0.19                      | -0.01                     |
| <b>WSSQ- F1</b> |                              |            |            |             |                           |                           |                           |                           |
| Item 1          | 0.71                         | -0.14      | 1.45       | 1.45        | -0.30                     | -0.36                     | -0.10                     | -0.07                     |
| Item 2          | 0.81                         | -0.36      | 0.93       | 0.94        | 0.11                      | 0.31                      | 0.01                      | -0.11                     |
| Item 3          | 0.88                         | -0.05      | 0.74       | 0.73        | 0.32                      | 0.23                      | -0.06                     | -0.20                     |
| Item 4          | 0.89                         | 0.67       | 0.82       | 0.77        | -0.15                     | -0.14                     | 0.02                      | 0.21                      |
| Item 5          | 0.79                         | -0.20      | 1.22       | 1.21        | -0.15                     | -0.22                     | -0.02                     | 0.13                      |
| Item 6          | 0.90                         | 0.07       | 0.83       | 0.81        | 0.17                      | 0.19                      | 0.15                      | 0.03                      |
| <b>WSSQ- F2</b> |                              |            |            |             |                           |                           |                           |                           |
| Item 7          | 0.86                         | -0.85      | 1.42       | 1.39        | 0.37                      | 0.27                      | -0.33                     | -0.23                     |
| Item 8          | 0.93                         | 0.33       | 0.58       | 0.57        | -0.20                     | -0.02                     | -0.03                     | -0.01                     |
| Item 9          | 0.92                         | 0.28       | 0.63       | 0.61        | -0.16                     | 0.13                      | -0.19                     | -0.05                     |
| Item 10         | 0.92                         | -0.14      | 0.7        | 0.67        | -0.12                     | -0.30                     | 0.35                      | 0.22                      |
| Item 11         | 0.93                         | 0.26       | 0.55       | 0.53        | -0.25                     | -0.01                     | 0.04                      | 0.04                      |
| Item 12         | 0.93                         | 0.12       | 0.61       | 0.58        | 0.00                      | -0.08                     | 0.15                      | 0.03                      |

<sup>a</sup>Based on confirmatory factor analysis

DIF contrast<sup>b</sup> across sex (Male-Female); DIF contrast<sup>c</sup> across weight status (Overweight-Normal); DIF contrast<sup>d</sup> across weight status (Obesity-Normal); DIF contrast<sup>e</sup> across weight status (Underweight-Normal)

PWSS: Perceived Weight Stigma Scale

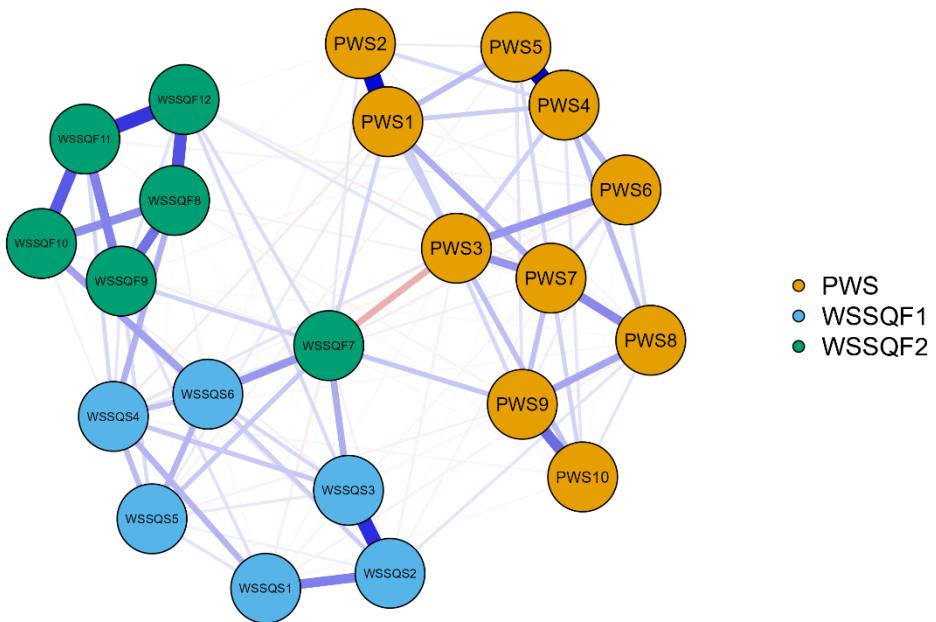
WSSQ F1: Weight Self-Stigma Questionnaire Factor 1 (Self-devaluation)

WSSQ F2: Weight Self-Stigma Questionnaire Factor 2 (Fear of enacted stigma)

Table 4. Model fit indices for CFA of PWS and WSSQ and SEM analysis with DASS-21

|   | $\chi^2 (df)$ | CFI   | NNFI  | RMSEA<br>(90% Confidence Interval) | SRMR  |
|---|---------------|-------|-------|------------------------------------|-------|
| PWSQ  | 200.59 (35)   | 0.996 | 0.994 | 0.022<br>(0.019-0.025)             | 0.031 |
| WSSQ  | 390.12 (53)   | 0.999 | 0.998 | 0.025<br>(0.023-0.028)             | 0.025 |
| CFA of the two stigma scales                    | 981.55 (206)  | 0.997 | 0.997 | 0.019<br>(0.018-0.021)             | 0.026 |
| Concurrent validity with psychological distress | 1208.36 (269) | 0.997 | 0.997 | 0.019<br>(0.018-0.020)             | 0.026 |
| Concurrent validity with Depression             | 1494.91 (371) | 0.997 | 0.997 | 0.017<br>(0.016-0.018)             | 0.025 |
| Concurrent validity with Anxiety                | 1784.41 (371) | 0.997 | 0.996 | 0.020<br>(0.019-0.020)             | 0.026 |
| Concurrent validity with Stress                 | 1573.58 (371) | 0.997 | 0.997 | 0.018<br>(0.017-0.019)             | 0.025 |

Notes: PWS = Perceived Weight Stigma; WSSQ: Weight Self-Stigma Questionnaire; CFA = confirmatory factor analysis; CFI = comparative fit index; NNFI = non-normed fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual



**Figure 1.** Network analysis of variables in the cross-sectional survey. PWS=perceived weight stigma; WSSQF1 = weight self-stigma-self-devaluation; WSSQF2 = weight self-stigma-fear of enacted stigma