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Association between a body shape index and low back pain: a cross-sectional study highlighting gender-specific differences in NHANES data

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Abstract

Background This study aimed to investigate the association between A Body Shape Index (ABSI) and low back pain, with a focus on gender and age differences, using cross-sectional data from the NHANES database.

Methods A total of 14,268 participants were included from four NHANES cycles (1999–2004 and 2009–2010). Low back pain was assessed based on self-reported pain over the past three months, and ABSI was calculated using waist circumference, height, and weight. Multivariate logistic regression models were used to evaluate the association between ABSI and low back pain, adjusting for potential confounders. Restricted cubic spline (RCS) analysis was conducted to assess non-linear relationships, and subgroup analyses were performed based on gender, age and BMI.

Results Higher ABSI was significantly associated with an increased risk of low back pain (OR for highest quartile = 1.27, 95% CI: 1.07–1.50, $p = 0.008$). RCS analysis indicated a linear relationship between ABSI and low back pain, with the risk significantly rising when ABSI exceeded 0.85. Subgroup analyses revealed that this association was more pronounced in males (OR = 25.89, 95% CI: 3.11-215.86, $p = 0.004$) and participants aged ≥ 60 years (OR = 11.11, 95% CI: 2.61–47.26, $p = 0.002$), while no significant association was observed in females.

Conclusions The ABSI was associated with low back pain. This association was more prominent in males and older adults. Our findings suggest that ABSI may provide a more nuanced understanding of low back pain risk, particularly

Background

Low back pain is one of the most common health problems worldwide, affecting the quality of life for a large number of patients and becoming a major cause of disability and loss of work capacity [1, 2]. Research estimates that 80% of the population will experience low back pain at least once in their lifetime [3], which not only causes individual suffering but also imposes a significant burden on healthcare systems and the global economy. This is particularly evident in occupational settings, where low back pain leads to absenteeism and reduced productivity. Patients with chronic low back pain may also suffer

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in populations with abdominal obesity. Further studies are needed to explore the underlying mechanisms and potential clinical applications of ABSI in low back pain risk assessment.

Keywords A body shape index (ABSI), Low back pain, Abdominal obesity, Gender differences, NHANES

from psychological issues, such as anxiety and depression, which further diminish their quality of life [4]. The etiology of low back pain is complex, involving biological, behavioral, and psychosocial factors, including obesity, smoking, sedentary behavior, physical labor, and poor posture [5]. Genetic factors, age, and gender differences also play important roles in the onset and progression of low back pain.

In recent years, the A Body Shape Index (ABSI), a new anthropometric measure, has been widely applied[[6–9]. Compared to the traditional body mass index (BMI), ABSI more effectively reflects abdominal fat distribution, particularly visceral fat, which is closely linked to various health risks [10]. Numerous studies have demonstrated that ABSI has a higher predictive capability for cardiovascular diseases, hypertension, diabetes, and cancers, especially in relation to metabolic disorders and visceral fat-associated diseases [7–9]. Since ABSI captures the distribution of abdominal fat, it is particularly relevant for individuals with normal BMI but excessive abdominal fat, highlighting its potential for broad application in health risk prediction.To address the high correlation between BMI and waist circumference (WC), newer measures like ABSI have emerged to complement BMI. By combining waist circumference, height, and weight, ABSI isolates abdominal fat distribution, providing a more precise assessment, particularly for those with normal BMI but excess abdominal fat [11].

Although significant progress has been made in understanding the role of ABSI in cardiovascular and metabolic diseases, its role in musculoskeletal disorders, particularly low back pain, has been insufficiently studied. The occurrence of low back pain is influenced by a range of factors; however, most current studies focus on traditional metrics such as BMI, with limited attention to the potential impact of abdominal fat distribution on low back pain [12]. Existing research suggests that the accumulation of abdominal fat not only increases the mechanical load on the spine but may also accelerate intervertebral disc degeneration through systemic chronic inflammation, thereby contributing to the development of low back pain [13–15]. Therefore, it is of critical importance to investigate the association between ABSI and low back pain.

This study aims to analyze the relationship between ABSI and low back pain, with a particular focus on gender differences through subgroup analyses. Utilizing cross-sectional data from the NHANES database, we seek to explore the role of ABSI in predicting the risk of low back pain, providing a theoretical basis for future individualized prevention and treatment strategies based on gender differences.

Methods

Study design and data source

This study utilized a cross-sectional design, with data drawn from the National Health and Nutrition Examination Survey (NHANES), covering four survey cycles from 1999 to 2004 and 2009–2010 ($n = 41,663$). We excluded participants with missing data on low back pain ($n = 5,241$) and A Body Shape Index (ABSI) ($n = 2,041$). A total of 14,268 participants were included in the final analysis (Fig. 1). NHANES is a nationally representative health survey employing a complex, multistage sampling design to collect data on the health status, nutrition, and associated risk factors of the non-institutionalized U.S. population. The study was approved by the National Center for Health Statistics (NCHS) Ethics Review Board, and informed consent was obtained from all participants.

Definition and measurement of variables

The outcome variable in this study was low back pain, which was obtained through a questionnaire. Participants were asked whether they had experienced low back pain in the past three months. ABSI, the exposure variable, was calculated based on participants' waist circumference, height, and weight using the following formula: ABSI = waist circumference / (BMI^(2/3) * height^(1/2)), where BMI is the body mass index, calculated as weight (kg) divided by height (m) squared [16, 17]. ABSI was categorized into quartiles (Q1-Q4) for further analysis.

Covariates

Several covariates were considered in this study to control for potential confounding factors. These included age (recorded in years), poverty income ratio (PIR), race/ethnicity (Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, and Other Race), alcohol consumption (yes/no), education level (less than high school, high school, and above high school), smoking status (yes/no), diabetes status (yes/no), marital status (married/living with a partner and widowed/divorced/separated/never married), and gender (male/female), BMI. These data were collected through standardized NHANES questionnaires and interviews. PIR was calculated by dividing family income by the poverty threshold, adjusted for family size. Smoking status was defined as having smoked at least 100 cigarettes in a lifetime, while

Fig. 1 Inclusion and exclusion criteria flowchart

alcohol consumption was defined as having consumed at least 12 alcoholic drinks in a lifetime. Diabetes status was determined by self-report. The collection of all covariate data followed NHANES standardized procedures, with more detailed information available at http://www.cdc.gov/nchs/nhanes/.

Statistical analysis

Various statistical methods were employed in this study. First, we used the svydesign function to account for the complex sampling design of NHANES by incorporating sample weights, strata, and primary sampling units. The svyglm function was then used to fit generalized linear models (GLMs) to examine the linear relationship between ABSI and low back pain. Subgroup analyses were conducted based on gender (male, female), age (< 60 years, ≥ 60 years) and BMI(BMI < 18.5,18.5 < = BMI < = 24.9,25 < = BMI < = 29.9,BMI > = 30). All models used a quasibinomial distribution, with low back pain as the dependent variable and ABSI as the independent variable, adjusting for covariates including age, gender, education level, race/ethnicity, marital status, alcohol consumption, smoking status, PIR, and diabetes status. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs).

To assess the association between ABSI and low back pain, multilevel regression analyses were performed. Three models were constructed: Model 1 was unadjusted, directly analyzing the relationship between ABSI and low back pain; Model 2 adjusted for age and gender; and Model 3 further adjusted for additional covariates, including and, gender, education level, race/ethnicity, marital status, alcohol consumption, smoking status, PIR, and diabetes status. All regression analyses were conducted using GLMs, with low back pain as the dependent variable and ABSI as the independent variable. Results were expressed as ORs with 95% CIs. A trend test was also conducted to evaluate the dose-response relationship between different ABSI quartiles and the risk of low back pain. All statistical analyses were performed using R software, and a p-value < 0.05 was considered statistically significant.

To further explore the potential non-linear relationship between ABSI and low back pain, restricted cubic spline (RCS) analysis was applied. The RCS model allows for the capture of potential non-linear associations between variables without assuming linearity. We selected 3 knots

to fit the RCS model and evaluated the non-linear effect of ABSI on low back pain. The significance of the RCS analysis was assessed by overall and non-linear p-values. A significant non-linear p-value would suggest the presence of a significant non-linear association between ABSI and low back pain.

Results

Population characteristics

A total of 14,268 participants were included in this study, with 5,751 reporting low back pain and 8,517 reporting no low back pain (Table 1). Significant differences were observed in many demographic characteristics between those with and without low back pain. First, the proportion of women in the low back pain group was significantly higher than that of men (56.1% vs. 43.9%, $p < 0.001$). Education level also showed a slight difference, with a higher proportion of participants having high school education or above in the group without low back pain (68.9% vs. 67.0%, $p = 0.007$). Regarding race/ethnicity, Non-Hispanic Whites and Mexican Americans were more represented in the low back pain group (53.2% and 19.8%, $p < 0.001$). Smoking status also varied significantly, with current smokers making up a larger proportion of the low back pain group (26.2% vs. 20.7%, $p < 0.001$). Analysis of the poverty income ratio (PIR) revealed that low-income participants were more likely to report low back pain (32.0% vs. 27.2%, $p < 0.001$). Additionally, the mean ABSI in the low back pain group was significantly higher than that in the no low back pain group (0.82 vs. 0.81, $p < 0.001$).

Regression analysis

Multilevel regression analysis was performed to investigate the association between ABSI and the occurrence of low back pain (Table 2). Model 1 was unadjusted,

Table 1 Characteristics of study participants ($n = 14,268$)

	Total participants	Low back pain	Non-low back pain	*P*-value
	***N* = 14,268**	***N* = 5751**	***N* = 8517**	
Age	48.9 (18.5)	48.8 (17.9)	49.0 (18.9)	0.597
Gender:				<0.001
Male	6779 (47.5%)	2524 (43.9%)	4255 (50.0%)	
Female	7489 (52.5%)	3227 (56.1%)	4262 (50.0%)	
edu:				0.007
< High school	2143 (15.0%)	860 (15.0%)	1283 (15.1%)	
Completed high school	2399 (16.8%)	1036 (18.0%)	1363 (16.0%)	
> High school	9706 (68.1%)	3849 (67.0%)	5857 (68.9%)	
Race:				<0.001
Mexican American	3217 (22.5%)	1138 (19.8%)	2079 (24.4%)	
Other Hispanic	690 (4.84%)	326 (5.67%)	364 (4.27%)	
Non-Hispanic White	7159 (50.2%)	3058 (53.2%)	4101 (48.2%)	
Non-Hispanic Black	2687 (18.8%)	1035 (18.0%)	1652 (19.4%)	
Other Race	515 (3.61%)	194 (3.37%)	321 (3.77%)	
Marital_new:				0.266
Married/Living with partner	8575 (62.1%)	3420 (61.6%)	5155 (62.5%)	
Widowed/Divorced/Separated/Never married	5228 (37.9%)	2136 (38.4%)	3092 (37.5%)	
Alcohol_Status:				0.493
Yes	3561 (71.0%)	1569 (71.5%)	1992 (70.6%)	
No	1455 (29.0%)	625 (28.5%)	830 (29.4%)	
Smoke:				<0.001
Never	7227 (50.7%)	2653 (46.2%)	4574 (53.8%)	
Former	3764 (26.4%)	1587 (27.6%)	2177 (25.6%)	
Current	3263 (22.9%)	1505 (26.2%)	1758 (20.7%)	
PIR:				<0.001
low income(< 1.3)	3801 (29.2%)	1691 (32.0%)	2110 (27.2%)	
medium income(1.3 to < 3.5)	5016 (38.5%)	2032 (38.5%)	2984 (38.5%)	
high income(> = 3.5)	4215 (32.3%)	1556 (29.5%)	2659 (34.3%)	
Diabetes:				0.057
Yes	464 (10.6%)	197 (11.7%)	267 (9.85%)	
No	3931 (89.4%)	1486 (88.3%)	2445 (90.2%)	
BMI	28.5 (6.37)	29.3 (6.86)	27.9 (5.95)	< 0.001
ABSI	0.814 (0.0524)	0.816 (0.0521)	0.812 (0.0525)	<0.001

Table 2 Associations of ABSI with low back pain

Exposures	Model 1		Model 2		Model 3	
ABSI	OR(CI95%)	P	OR(CI95%)	P	OR(CI95%)	P
Q1	ref		ref		ref	
Q2	1.07(0.96,1.20)	0.19	1.11(0.99,1.25)	0.06	1.10(0.79,1.25)	0.11
Q3	1.07(0.93,1.23)	0.29	1.13(0.97,1.31)	0.11	1.08(0.92,1.26)	0.33
Q4	1.29(1.13,1.47)	< 0.001	1.37(1.17,1.60)	< 0.001	1.27(1.07,1.50)	0.008
P trend	0.002		0.001		0.01	

Model 1: Non-adjusted

Model 2: Adjusted for age and gender

Model 3: Adjusted for age, Gender, edu, Race, Marital_new, Alcohol_Status, Smoke, PIR, Diabetes

Model 2 adjusted for age and gender, and Model 3 further adjusted for age, gender, education level, race/ethnicity, marital status, alcohol consumption, smoking status, poverty income ratio (PIR), and diabetes status. In the unadjusted model (Model 1), participants in the highest ABSI quartile had a significantly higher risk of low back pain (OR = 1.29, 95% CI: 1.33–1.47, $p < 0.001$). This association remained significant in the adjusted models (Model 2: OR = 1.37, 95% CI: 1.17–1.60, $p = 0.001$; Model 3: OR = 1.27, 95% CI: 1.07–1.50, $p = 0.008$). In contrast, no statistically significant association was observed for participants in the lower ABSI quartiles (Q1 to Q3) with respect to low back pain. Trend tests further supported this association, with all models showing statistically significant P-values for trend (Model 1: $P = 0.002$, Model 2: $P = 0.001$, Model 3: $P = 0.01$).

Restricted cubic spline (RCS) analysis

To further explore the potential non-linear association between ABSI and low back pain, we performed a restricted cubic spline (RCS) analysis (Fig. 2). The results showed an overall P-value < 0.001, indicating a significant association between ABSI and low back pain. However, the non-linear P-value was 0.49, suggesting that the association did not present a statistically significant non-linear trend. This implies that the relationship between ABSI and low back pain is better explained by a linear trend, with the risk of low back pain progressively increasing as ABSI rises. The graph shows that when ABSI exceeds 0.85, the risk of low back pain increases substantially. This finding suggests that individuals with higher ABSI values may be at greater risk for low back pain, especially when ABSI reaches or exceeds a certain threshold. Given that the non-linear P-value was not significant, we conclude that the association between ABSI and low back pain aligns more with a linear hypothesis, where the risk of low back pain increases steadily with higher ABSI.

Subgroup analysis

To further investigate the association between ABSI and low back pain, we conducted subgroup analyses stratified by gender, age and BMI (Fig. 3). The results showed a stronger positive association between ABSI and low back pain in males and participants aged ≥ 60 years, while no statistically significant association was observed in females. In males, participants in the highest ABSI quartile had a significantly higher risk of low back pain (OR = 25.89, 95% CI: 3.11-215.86, $p = 0.004$), indicating that higher ABSI substantially increases the risk of low back pain among men. In contrast, while a trend was observed in females (OR = 1.89, 95% CI: 0.43–8.26), it did not reach statistical significance ($p = 0.400$). Age-stratified analysis also demonstrated a significant association between ABSI and low back pain. In the group aged < 60 years, higher ABSI was associated with an increased risk of low back pain (OR = 7.64, 95% CI: 2.08–28.11, $p = 0.004$), and this association was even more pronounced in the group aged ≥ 60 years (OR = 11.11, 95% CI: 2.61–47.26, $p = 0.002$). These subgroup analysis results suggest that ABSI has a more significant impact on low back pain in men and older adults, highlighting the potential moderating effects of gender and age on the relationship between ABSI and low back pain.

In the BMI stratification analysis, the relationship between ABSI and low back pain exhibited varying trends across different BMI groups. In the BMI < 18.5 group, although the OR was 0.42 (95% CI: 0, 599.62) with a p-value of 0.816, the result did not reach statistical significance, and the wide confidence interval indicated a lack of reliability in the data. In the 18.5 ≤ BMI ≤ 24.9 group, ABSI showed an OR of 5.73 (95% CI: 0.82, 40.12) with a p-value of 0.084599. While the OR was greater than 1, indicating an increased risk, the p-value was close to 0.05 and did not reach statistical significance, suggesting a potential risk increase but insufficient to draw a definitive conclusion.In the 25 ≤ BMI ≤ 29.9 group, the association between ABSI and low back pain was statistically significant (OR = 10.19, 95% CI: 1.21, 86.2, $p = 0.038$), indicating that abdominal obesity significantly increases the risk of low back pain in overweight individuals. In the BMI ≥ 30 group, the association between ABSI and low back pain did not reach statistical significance (OR = 3.31, 95% CI: 0.48, 22.71, $p = 0.228$), suggesting that the impact

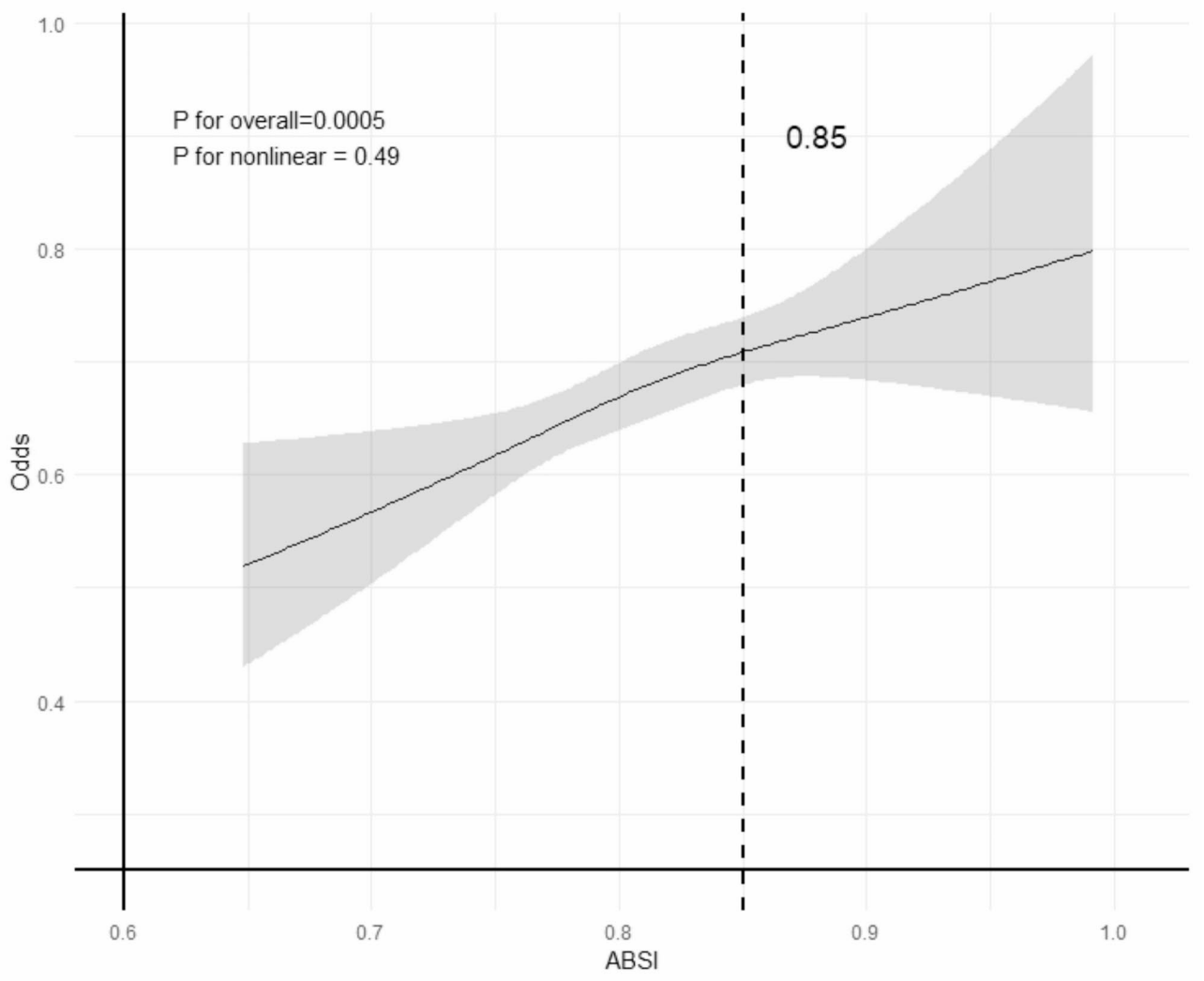

Fig. 2 Restricted Cubic Spline (RCS) analysis of the association between ABSI and low back pain risk

of abdominal obesity may not be as pronounced in obese individuals as in overweight individuals.Overall, the BMI stratification analysis revealed a significant association between ABSI and low back pain primarily in the overweight group ($25 \leq BMI \leq 29.9$), while no significant association was observed in the $BMI < 18.5$ and $BMI \geq 30$ groups. The effect of abdominal obesity on low back pain differs across BMI ranges, suggesting that BMI may modulate the impact of abdominal obesity on low back pain.

Discussion

This study analyzed cross-sectional data from the NHANES database to explore the association between A Body Shape Index (ABSI) and the risk of low back pain. Our findings suggest a positive correlation between higher ABSI and the occurrence of low back pain, with this association being particularly significant in males and older adults. For the first time, we confirmed the linear relationship between ABSI and low back pain using Restricted Cubic Spline (RCS) analysis, demonstrating that the risk of low back pain increases significantly when ABSI exceeds a certain threshold. These findings provide evidence supporting the potential application of ABSI as a predictor of low back pain risk and emphasize that gender and age should be considered as important moderators in assessing low back pain risk.

Although existing research primarily focuses on the relationship between BMI and low back pain, ABSI, which more accurately reflects abdominal fat distribution, has been less studied in musculoskeletal disorders. While BMI is a commonly used measure for assessing obesity and body composition, it only accounts for overall weight relative to height and does not differentiate between fat and muscle mass or reflect fat distribution, especially the accumulation of abdominal fat [18]. Several studies have shown that although waist circumference and height can partially reflect body composition, they fail to precisely capture an individual's metabolic risk,

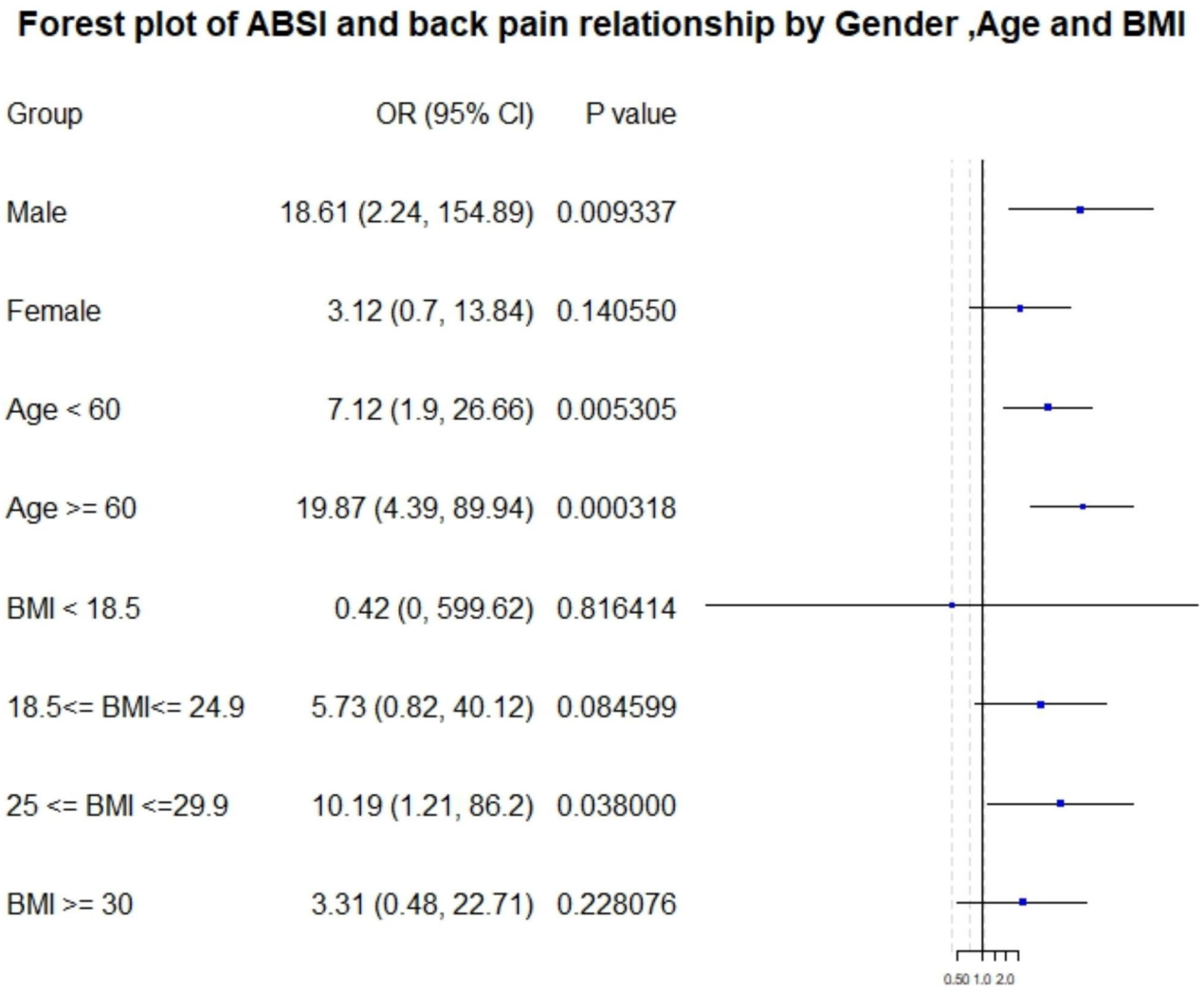

Fig. 3 Forest plot of stratified analysis and interaction effects for the association between ABSI and low back pain by gender and age

particularly in terms of visceral fat accumulation [19, 20]. Although a larger waist circumference may indicate a higher risk of low back pain, considering waist circumference alone does not adequately account for overall body composition and total weight [6, 21, 22].

Our study results indicate a significant positive correlation between ABSI and low back pain, particularly in males and older adults. Studies have shown that the accumulation of abdominal fat can elevate the body's inflammatory response [23, 24], suggesting that it may exacerbate low low back pain by increasing the mechanical load on the spine or triggering systemic inflammation. Compared to BMI, height, or waist circumference, ABSI better reflects abdominal fat distribution and can more accurately predict obesity-related health risks. This aligns with previous studies, which have demonstrated that increased abdominal fat can significantly raise the pressure on intervertebral discs, leading to disc degeneration and, consequently, low back pain [15, 25]. Therefore, our study suggests that ABSI may outperform traditional single measures in assessing low back pain risk, particularly in evaluating the impact of abdominal fat accumulation on the spine.

Subgroup analysis revealed the moderating effects of gender and age on the relationship between ABSI and low back pain. We found that higher ABSI was significantly associated with low back pain risk in males, whereas this association was not statistically significant in females. This finding is consistent with previous studies on gender differences in the relationship between obesity and low back pain [26]. Males, due to their higher proportion of visceral fat, may be more prone to low back pain resulting from increased spinal load and inflammation [27–29]. In contrast, although females generally have higher total body fat, most of it is subcutaneous, which may exert less direct mechanical stress on the spine. Additionally,

hormonal differences, particularly the anti-inflammatory effects of estrogen in females [30, 31], may contribute to these gender disparities. Furthermore, abdominal obesity in males might place more strain on the lower back, but females, with their wider pelvis designed for childbirth, may be better equipped to bear abdominal weight, reducing the likelihood of low back pain [32].

Age-related differences were also observed in our study. Higher ABSI was significantly associated with an increased risk of low back pain in older adults, which may be attributed to the more pronounced degenerative changes in intervertebral discs and musculoskeletal function with age [33]. Higher ABSI values may further exacerbate these degenerative processes, increasing the likelihood of low back pain. In contrast, younger individuals, with less severe spinal degeneration, may experience less impact from abdominal fat accumulation on the spine.

In the BMI subgroup analysis, we found that the association between ABSI and low back pain was most pronounced in individuals with a BMI of 25-29.9 (overweight), where the odds ratio (OR) was statistically significant. This suggests that abdominal obesity in the overweight group significantly increases the risk of low back pain. In contrast, no significant association was observed in the underweight (BMI < 18.5) and obese (BMI ≥ 30) groups. The lack of significance in the underweight and obese groups may be attributed to other confounding factors, indicating that abdominal fat distribution might play a more crucial role in the overweight population for low back pain risk. Further studies are needed to explore these mechanisms.

ABSI reflects abdominal fat distribution, and visceral fat is considered a key driver of systemic inflammation [34–36]. Research indicates that visceral fat secretes a substantial amount of pro-inflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) [37, 38], which not only elevate systemic inflammation but may also directly act on intervertebral discs, promoting degeneration. IL-6 and TNF-α are two key pro-inflammatory cytokines that promote intervertebral disc degeneration and, consequently, low back pain through multiple signaling pathways [39, 40]. First, IL-6 and TNF-α can activate the NF-κB pathway, a well-known inflammatory signaling pathway that increases the expression of inflammatory mediators, promoting matrix degradation and apoptosis of disc cells [41]. Through this mechanism, these cytokines induce the release of matrix metalloproteinases (MMPs) and other degrading enzymes in the intervertebral disc, disrupting its structure and function. Additionally, IL-6 and TNF-α can modulate cell metabolism and survival through the JAK-STAT pathway, further exacerbating the inflammatory response and damage in disc cells [42]. Under the influence of these cytokines, inflammation and degeneration of the intervertebral disc tissue are amplified, leading to reduced hydration and elasticity of the discs, eventually resulting in disc degeneration and low back pain. Therefore, IL-6 and TNF-α may play a crucial role in low back pain through direct actions on disc cells and the degradation of disc tissue. Additionally, increased abdominal fat directly adds mechanical load to the lumbar spine, promoting disc degeneration and muscle fatigue, which exacerbates low back pain. Obesity may also elevate the risk of spondylolisthesis by increasing pelvic incidence, further contributing to low back pain [43].Furthermore, obesity can lead to the development of lumbar facet joint arthritis, which exacerbates pain through joint degeneration and inflammation [44]. These mechanisms likely explain the positive correlation between ABSI and low back pain observed in our study.

This study has several limitations that should be considered when interpreting the findings. First, due to the cross-sectional design of this study, causality between ABSI and low back pain cannot be established. While a significant association was observed, we cannot infer that ABSI directly causes low back pain. Therefore, the results should be interpreted with caution, and future research with longitudinal designs is needed to better understand the directionality of the relationship. Second, our analysis relied on self-reported data for both ABSI and low back pain, which introduces the potential for reporting bias. Self-reports may be influenced by factors such as individual pain sensitivity or recall bias, and the absence of clinical diagnoses from healthcare professionals could affect the accuracy of the reported outcomes. To reduce this bias, future studies should consider incorporating clinical diagnoses and medical records, along with more objective measures, to validate the self-reported data. Lastly, while multiple potential confounders were adjusted for in this study, there may still be residual confounding factors, such as lifestyle behaviors, physical activity levels, or unmeasured health conditions, that could influence the observed relationship between ABSI and low back pain. Further research should aim to control for these residual confounders to provide a more accurate assessment of the association. Moreover, prospective studies would help clarify the causal pathways and further strengthen the findings.

Despite its limitations, the results of this study offer new insights into risk assessment for low back pain. ABSI, as an easily obtainable measure of body shape, can help clinicians better identify high-risk populations, particularly in males and older adults. For individuals with a high ABSI, particularly those with abdominal obesity, early intervention measures may help prevent the occurrence of low back pain. For example, strategies aimed at reducing abdominal fat, such as weight management and

core muscle training, may effectively lower the risk of low back pain. In clinical practice, it is recommended to incorporate ABSI into routine screening protocols, especially for individuals at risk of low back pain. By evaluating ABSI during regular health examinations or medical consultations, healthcare providers can identify high-risk patients early and tailor preventive and intervention measures accordingly. For instance, for patients with high ABSI values, it is advisable to recommend physical therapy, core muscle strengthening exercises, and personalized nutrition and lifestyle interventions to help mitigate the burden of abdominal fat on the spine. Furthermore, future public health strategies should also consider including ABSI in regular screening to facilitate the early identification of high-risk individuals, thereby allowing for timely interventions to reduce the incidence and progression of low back pain. By integrating ABSI with other known risk factors, such as physical activity levels, core muscle strength, and spinal alignment, future research can provide a more targeted theoretical basis for developing personalized prevention and treatment strategies.

Future longitudinal studies are needed to further explore the causal relationship between ABSI and low back pain. Additionally, combining research on biomarkers could help clarify the specific mechanisms through which abdominal fat contributes to the development of low back pain. Moreover, the moderating effects of gender and age on this association warrant further investigation, which could guide individualized prevention and treatment strategies.Importantly, future studies could explore the role of potential mediators, such as physical activity, core muscle strength, and lumbar spine alignment, in the ABSI-low back pain relationship, providing a more detailed pathway for understanding how abdominal obesity impacts low back pain.

Conclusion

This study found a significant association between the ABSI and low back pain, particularly among males and older adults. Gender and age were identified as important factors that moderate this relationship, suggesting that individual characteristics should be considered when assessing the risk of low back pain and designing targeted interventions. Although ABSI is a relatively novel measure, it may offer potential as a clinical tool for assessing low back pain risk, particularly in populations with abdominal obesity.

Abbreviations

ABSI	A Body Shape Index
RCS	Restricted cubic spline
BMI	Body mass index
NHANES	National Health and Nutrition Examination Survey
NCHS	National Center for Health Statistics
PIR	Poverty income ratio
GLMs	Generalized linear models
ORs	Odds ratios
Cis	Confidence intervals
IL-6	Interleukin-6
TNF-α	Tumor necrosis factor-alpha

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Author contributions

SWX and HX contributed equally to this work. SWX and HX wrote the manuscript and conducted statistical analysis. GWL and JGZ searched the data. YPL 、 FZ and MWL designed the study, and revised the manuscript. All authors read and approved the final manuscript.

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Data availability

The dataset supporting the conclusions of this article is available in the NHANES repository, https://www.cdc.gov/nchs/nhanes.

Declarations

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

The survey protocols received approval from the Ethics Review Board of the National Center for Health Statistics (NCHS), and documented consent was obtained from participants (Protocol #98 – 12, Continuation of Protocol #2005-06).

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