ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 22(11): 8741-8745 (2026)

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BIOINFORMATION
Discovery at the interface of physical and biological sciences

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 22(11)

Research Article

Received November 01, 2026; Revised November 30, 2026; Accepted November 30, 2026, Published November 30, 2026

DOI: 10.6026/973206300228741

SJIF 2026 (Scientific Journal Impact Factor for 2026) is 8.677
ABCD 2026 index is 7.183
EA 2025 score is 0.37
2025 EA ranking:
72 of 353 in General Dentistry (associated subject; top 20.4%)
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

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Edited by Ruby Singh
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Citation: Shah & Shaikh Bioinformation 22(11): 8741-8745 (2026)

Sibling status as a correlate of adiposity and metabolic health in young Gujarat adults

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ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(11): 8741-8745 (2026)
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Abstract:
Obesity is a growing global problem, and early-life determinants of metabolic risk are attracting increasing interest. Therefore, it is of interest to examine the association of sibling status with body composition, fasting blood glucose and physical activity in 176 healthy young adults (18–22 years) from Gujarat, India. Females without siblings had significantly higher body mass index (24.22 vs. 20.90 kg/m², p = 0.002), visceral fat (6.14% vs. 3.11%, p = 0.0009) and fasting blood glucose (92.34 vs. 89.38 mg/dL, p = 0.04), with lower physical activity (p = 0.04). Among males, only total body fat differed by sibling status (24.25% vs. 21.17%, p = 0.02). Thus, sibling status shows a sex-specific association with adiposity and metabolic health, although longitudinal studies are needed to clarify its direction and mechanisms.

Keywords: Siblings, family characteristics, body composition, adiposity, visceral fat, blood glucose, physical activity, young adult

Background:
Obesity has emerged as one of the foremost public-health challenges worldwide, with close to one in eight adults classified as obese in 2022 and prevalence rising sharply since 1990 **[1].** Obesity and its associated insulin resistance are closely linked to the growing global burden of type 2 diabetes mellitus, underscoring the need to identify early-life determinants of long-term metabolic health **[2]**. The association between family structure, the number of siblings in a household and childhood body mass index is well documented, although its persistence into adulthood remains equivocal **[3]**. Longitudinal evidence indicates that children without siblings follow higher BMI trajectories and that only children are at greater risk of raised BMI in later childhood **[4]**. Population-based data further link sibling number and birth order to childhood overweight, pointing to family composition as a potentially modifiable contextual factor **[5]**. Childhood adiposity is itself a longitudinal predictor of adult-onset diabetes, a concern amplified in South Asian populations where visceral adiposity develops at younger ages and lower BMIs than in European populations **[6]**. Life-course analyses of sibling group size and BMI have produced mixed findings, with early weight differences sometimes narrowing with age **[7]**. Other cohorts report that only or last-born children carry an increased long-term risk of obesity **[8]**. A parallel body of work on birth order has linked firstborn, last-born or only-child status to less favourable body composition and metabolic outcomes in young adulthood **[9]**. Family composition may influence weight development through several interconnected behavioural, socioeconomic and environmental pathways **[10]**. The number of children in a household can affect parental attention, food allocation, meal routines, opportunities for physical activity and the establishment of health-related behaviours **[11]**. In smaller families, parents may have greater financial resources and time to devote to each child, potentially increasing access to energy-dense foods, electronic devices and sedentary recreational activities **[12]**. Conversely, larger families may experience resource constraints that influence dietary quality, healthcare access and participation in organized physical activities. However, these relationships are not necessarily linear, as household income, parental education, cultural practices and neighbourhood characteristics may modify the association between family size and adiposity **[13]**. Birth order may also contribute to differences in growth and metabolic health through variations in parental behaviour and early-life exposures. Firstborn children may receive greater parental attention and experience different feeding practices than their younger siblings **[14]**. Later-born children, in contrast, may adopt the dietary and physical activity habits of older siblings, potentially influencing their energy balance and body composition **[15]**. Nevertheless, birth order should not be interpreted as an independent biological determinant of obesity without considering maternal characteristics, birth weight, breastfeeding practices, childhood nutrition and the interval between pregnancies. These factors may partly explain the inconsistent associations reported across populations and study designs **[16]**. The relationship between sibling number and adult metabolic outcomes is particularly relevant in countries undergoing rapid nutritional and epidemiological transitions **[17]**. In India, changing household structures, urbanization, increased consumption of processed foods and declining levels of physical activity have contributed to a growing burden of overweight, obesity and type 2 diabetes **[18]**. South Asians may develop central adiposity and metabolic complications at comparatively lower BMI values, making the identification of early-life risk factors especially important. Understanding whether childhood family structure is associated with adult adiposity could therefore contribute to improved risk assessment and the development of targeted preventive strategies **[19]**. Therefore, it is of interest to report the association of sibling status with body-fat distribution, fasting blood glucose and habitual physical activity in young Gujarati adults, with attention to sex-specific differences, since fasting glucose is seldom examined as an independent outcome in this context.

Materials and Methods:
Study design and setting:
This cross-sectional observational study explored the association between sibling status and obesity, fasting blood glucose and physical activity in young adults. It was conducted in the Department of Physiology, Shantabaa Medical College, from March to December 2025, and reported according to the

ISSN 0973-2063 (online) 0973-8894 (print)
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Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Participants:
Healthy MBBS students aged 18–22 years of Gujarati ethnicity (mother tongue) who were willing to participate were enrolled. Exclusion criteria were endocrine or metabolic disorders, diabetes mellitus, medications affecting glucose metabolism, autonomic function or body composition, acute cardiovascular conditions, competitive athletics, current smoking or tobacco chewing, and pregnancy or lactation with hormonal disturbance. Participants were randomly selected from the pool of volunteers, yielding a final sample of 176.

Grouping and measurements:
After informed consent, a standardized questionnaire captured demographic and familial information including sibling status, and participants were divided into four groups by sex and sibling status ("only child" = no siblings; "with sibling(s)" = at least one brother or sister). Height and waist and hip circumferences were measured with standard technique, and body weight and composition - BMI, total body fat, visceral fat and regional skeletal-muscle and subcutaneous-fat percentages - were assessed by bioelectrical impedance analysis (Omron HBF-375 Karada Scan) after an 8–12 hour fast and abstinence from vigorous activity and caffeine.

Fasting glucose and physical activity:
Fasting blood glucose was measured from an overnight-fasting venous sample by the glucose oxidase–peroxidase enzymatic method on a fully automated analyser (calibrated daily with internal quality control), with results reported in mg/dL. Habitual physical activity was assessed using the NASA physical-activity rating scale, an 11-point (0–10) self-reported questionnaire.

Statistical analysis and ethics:
Continuous variables are presented as mean ± standard deviation. Normality was assessed for all continuous variables; sex-stratified between-group comparisons used the independent-samples Student's t-test for normally distributed data and the Mann–Whitney U test otherwise, with significance set at $p < 0.05$. The study was approved by the Institutional Ethics Committee of Shantabaa Medical College and General Hospital, Amreli (Approval No. 63/03/2024) and conducted in accordance with the Declaration of Helsinki, with written informed consent from all participants.

Results:
The final analysis included 176 young adults (18–22 years) grouped by sex and sibling status. Among female participants, the absence of siblings was associated with substantially higher BMI (24.22 ± 5.67 vs. 20.90 ± 4.35 kg/m²; p = 0.002) and waist circumference (71.92 ± 11.46 vs. 67.20 ± 9.16 cm; p = 0.03). Bioelectrical impedance analysis showed significantly greater total body fat (32.49 ± 6.51% vs. 29.11 ± 5.24%; p = 0.006) and, notably, visceral fat (6.14 ± 5.38% vs. 3.11 ± 2.56%; p = 0.0009) in only-child females. They also had higher fasting blood glucose (92.34 ± 7.16 vs. 89.38 ± 6.94 mg/dL; p = 0.04) and lower self-reported physical activity (p = 0.04), with higher subcutaneous trunk fat and lower trunk and leg skeletal-muscle percentages; other regional variables did not differ significantly **(Table 1).** Among male participants, between-group differences were markedly attenuated. The only significant difference was in total body fat, which was higher in only children than in men with siblings (24.25 ± 6.62% vs. 21.17 ± 5.98%; p = 0.02); BMI, waist circumference, visceral fat, regional fat and muscle distribution, physical activity and fasting glucose did not differ significantly **(Table 2).**

Table 1: Anthropometric, body-composition and metabolic characteristics of female participants, by sibling status

Parameter	With sibling(s) (mean ± SD)	Only child (mean ± SD)	p-value
BMI (kg/m²)	20.90 ± 4.35	24.22 ± 5.67	**0.002**
Waist circumference (cm)	67.20 ± 9.16	71.92 ± 11.46	**0.03**
Hip circumference (cm)	93.64 ± 9.38	97.52 ± 11.61	0.07
Body fat (%)	29.11 ± 5.24	32.49 ± 6.51	**0.006**
Visceral fat (%)	3.11 ± 2.56	6.14 ± 5.38	**0.0009**
Subcutaneous fat, whole body (%)	24.05 ± 5.41	26.35 ± 6.06	0.05
Subcutaneous fat, trunk (%)	20.46 ± 5.33	22.88 ± 6.23	**0.04**
Subcutaneous fat, arms (%)	41.78 ± 6.26	42.55 ± 9.55	0.65
Subcutaneous fat, legs (%)	36.96 ± 6.89	39.81 ± 9.47	0.10
Skeletal muscle, whole body (%)	26.27 ± 2.02	26.16 ± 3.58	0.85
Skeletal muscle, trunk (%)	21.69 ± 2.48	20.17 ± 3.66	**0.02**
Skeletal muscle, arms (%)	29.73 ± 4.35	29.99 ± 6.76	0.83
Skeletal muscle, legs (%)	37.29 ± 2.09	39.88 ± 5.38	**0.003**
Physical activity scale (0–10)	1.25 ± 0.76	0.90 ± 0.86	**0.04**
Fasting blood glucose (mg/dL)	89.38 ± 6.94	92.34 ± 7.16	**0.04**

Bold p-values indicate statistical significance (p < 0.05).
BMI, body mass index; SD, standard deviation.
Adiposity and metabolic outcomes in males

Table 2: Anthropometric, body-composition and metabolic characteristics of male participants, by sibling status

Parameter	With sibling(s) (mean ± SD)	Only child (mean ± SD)	p-value
BMI (kg/m²)	22.48 ± 3.50	23.54 ± 5.30	0.28
Waist circumference (cm)	74.74 ± 8.52	77.67 ± 11.86	0.19
Hip circumference (cm)	92.27 ± 8.76	95.38 ± 10.67	0.14
Body fat (%)	21.17 ± 5.98	24.25 ± 6.62	**0.02**
Visceral fat (%)	5.37 ± 3.29	6.77 ± 5.13	0.13
Subcutaneous fat, whole body (%)	15.60 ± 5.47	17.52 ± 6.01	0.12
Subcutaneous fat, trunk (%)	13.43 ± 4.80	15.35 ± 5.58	0.09
Subcutaneous fat, arms (%)	23.91 ± 8.17	26.29 ± 7.89	0.17
Subcutaneous fat, legs (%)	22.97 ± 7.73	25.80 ± 7.96	0.10
Skeletal muscle, whole body (%)	33.70 ± 3.17	32.86 ± 3.20	0.23
Skeletal muscle, trunk (%)	27.14 ± 3.75	26.18 ± 5.66	0.35
Skeletal muscle, arms (%)	38.29 ± 4.89	37.61 ± 5.56	0.55
Skeletal muscle, legs (%)	50.03 ± 4.51	48.94 ± 5.76	0.33
Physical activity scale (0–10)	2.56 ± 2.20	2.83 ± 2.43	0.25
Fasting blood glucose (mg/dL)	90.46 ± 8.61	90.14 ± 6.71	0.59

Bold p-values indicate statistical significance (p < 0.05).
BMI, body mass index; SD, standard deviation

Discussion:

This cross-sectional study examined the association of sibling status with body composition, fasting blood glucose, and physical activity among young Gujarati adults. The findings suggest that the relationship between sibling status and metabolic health may differ by sex. Associations were more pronounced among females, in whom the absence of siblings was associated with higher body mass index (BMI), waist circumference, total body fat, visceral fat, and fasting blood glucose levels, alongside lower self-reported physical activity. In contrast, among males, total body fat was the only parameter that differed significantly by sibling status. These findings highlight the potential influence of family structure on lifestyle behaviours and metabolic health during early adulthood. However, the cross-sectional design does not establish whether sibling status directly influences these outcomes. The higher BMI, waist circumference, and total body fat observed among only-child females are consistent with the findings of Ohara *et al.* **[20]** who identified birth order and sibship composition as potential predictors of overweight and obesity in young children. Family structure may influence weight-related outcomes through several pathways, including differences in parental attention, household routines, food availability, and opportunities for social interaction. Individuals with siblings may experience more frequent opportunities for shared play, recreational activities, and movement during childhood. Conversely, only children may have fewer opportunities for spontaneous physical activity within the household. Nevertheless, these mechanisms remain hypothetical in the present study because parental behaviours, household environments, and childhood activity patterns were not directly assessed. The lower self-reported physical activity among only-child females provides a potential behavioural explanation for their less favourable adiposity profile. This observation aligns with the systematic review and meta-analysis by Rodrigues *et al.* **[21]**. Similarly, Sun *et al.* **[22]** identified relationships between family size and adolescent health in a Chinese cross-sectional survey, supporting the possibility that household composition is associated with lifestyle behaviours and weight-related outcomes. Siblings may encourage movement through shared recreational activities, companionship, and informal competition. However, sibling relationships can also vary considerably, and the presence of siblings does not necessarily guarantee higher physical activity. Differences in family resources, neighbourhood safety, parental supervision, and access to recreational facilities may also contribute to the observed associations. The higher visceral fat and fasting blood glucose observed among sibling-absent females are also clinically relevant. South Asian populations are recognised as being susceptible to increased adiposity and metabolic abnormalities at comparatively lower BMI levels. Iliodromiti *et al.* **[23]** showed that individuals of South Asian descent exhibit greater visceral and hepatic fat accumulation than White Europeans at a given BMI, a pattern associated with increased metabolic risk. Visceral adipose tissue is metabolically active and may contribute to insulin resistance through altered free fatty acid metabolism, inflammatory signalling, and impaired glucose regulation. Therefore, the coexistence of higher adiposity and fasting glucose in only-child females may indicate a potentially unfavourable metabolic phenotype. However, insulin resistance and hepatic fat were not directly measured in this study, and the proposed physiological pathways should be interpreted as plausible explanations rather than demonstrated mechanisms. The sex-specific findings warrant particular consideration within the Indian sociocultural context. The association between sibling status and physical activity was evident among females but not males, suggesting that family structure may interact with gender-related influences on lifestyle. Mathews *et al.* **[24]** documented structural barriers to physical activity among Indian women, including social expectations, restricted mobility, safety concerns, and limited opportunities for recreation. Such constraints may reduce the likelihood of independent outdoor activities and increase dependence on household or family-based opportunities for movement. Consequently, having siblings could potentially provide additional opportunities for shared physical activity or social engagement among females **[25, 26]**. Nevertheless, the present findings do not establish that these factors explain the observed sex differences, and further research incorporating gender-related behavioural and environmental variables is required. An important implication of these findings is that BMI alone may not adequately capture differences in metabolic risk among young adults. The concurrent assessment of waist circumference, total body fat, visceral fat, and fasting blood glucose provides a broader understanding of body composition and glycaemic status. The observed differences suggest that early identification of unfavourable adiposity patterns may be particularly relevant in young South Asian females. Nevertheless, sibling status should not be considered an independent clinical risk marker without further validation. Preventive strategies should primarily emphasise regular physical activity, balanced nutrition, and appropriate metabolic screening according to individual risk profiles rather than family structure alone. This study has several strengths. Bioelectrical impedance analysis enabled a more detailed assessment of body composition than anthropometric measurements alone. Sex-stratified analyses also facilitated the identification of potentially important differences between males and females. Furthermore, the concurrent evaluation of physical activity, adiposity, and fasting blood glucose provided an integrated assessment of behavioural and metabolic characteristics.

Conclusion:

Sibling status showed sex-specific associations with adiposity and metabolic health in young Gujarat adults. Females without siblings exhibited greater visceral adiposity, higher fasting glucose and lower physical activity. Longitudinal studies are needed to establish these associations and clarify their long-term cardiometabolic implications.

Limitations:

Several limitations must also be acknowledged. First, the cross-sectional design precludes causal inference and prevents the

determination of whether sibling status preceded the observed differences in body composition and glycaemic measures. Second, recruitment from a single centre involving medical students of one ethnic background limits generalisability to other populations. Third, sibling status was recorded dichotomously, without accounting for birth order, number of siblings, sibling sex, age differences, or the quality of sibling relationships. Fourth, self-reported physical activity may be affected by recall and social desirability bias. Fifth, dietary intake, sleep patterns, sedentary behaviour, socioeconomic status, and psychosocial factors were not comprehensively assessed, leaving the possibility of residual confounding. Finally, the observed sex-specific associations require confirmation in larger studies with adequate statistical power and adjustment for relevant confounders. Future longitudinal and multicentre studies should investigate whether sibling status is independently associated with changes in adiposity and glycaemic regulation over time. Incorporating objective physical-activity measurements, dietary assessments, and additional metabolic biomarkers would help clarify the underlying pathways. Overall, the findings suggest that sibling status may be associated with body composition, physical activity, and fasting blood glucose in young Gujarati adults, with stronger associations observed among females. These results provide a basis for further investigation into the interplay between family structure, gender, and early metabolic health.

Ethics approval:
Approved by the Institutional Ethics Committee, Shantabaa Medical College and General Hospital, Amreli (No. 63/03/2024); written informed consent was obtained from all participants.

Conflict of interest: The authors declare no competing interests.

Availability of Data and material:
The datasets generated and analysed during the current study are not publicly available to maintain the confidentiality of data of study participants as per the informed consent obtained, but are available from the author upon reasonable request.

Acknowledgement:
We are grateful to the volunteers who took part in this study; without their participation, this work would not have been possible. We also thank the department of physiology, Shantabaa medical College, Amreli for providing the facilities needed to carry out the study.

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