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Milk consumption level and lifestyle diseases: A multi-stakeholder Correlational study using a lifestyle index in Salem District, Tamil Nadu, India

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ABSTRACT

Milk consumption is frequently associated with dietary behaviour and the risk of lifestyle-related diseases, yet empirical evidence from rural Indian contexts remains limited. The present study examined the relationship between milk consumption levels and lifestyle diseases using a multi-stakeholder approach in Salem district of Tamil Nadu, India. A total of 225 respondents (75 men, 75 women and 75 children) were selected through random sampling from three blocks representing varying levels of milk production and urbanization, along with expert inputs from ten medical practitioners and ten dieticians. A composite lifestyle index was developed to assess perceived lifestyle patterns and their association with disease prevalence. Correlation analysis indicated no statistically significant relationship between milk consumption level and lifestyle diseases at the district level (r = 0.062) or within individual blocks, Konganapuram (r = 0.039), Salem urban (r = 0.115) and Thalaivasal (r = 0.050). However, the lifestyle index showed a significant inverse association with lifestyle diseases in selected rural blocks, suggesting that broader behavioural factors may play a stronger role than milk intake alone. Consumption patterns also revealed that only one in ten urban respondents and one in seven rural respondents met recommended milk intake levels. The findings highlight the need to interpret dairy consumption within a wider lifestyle context rather than as an isolated determinant of health outcomes, and offer evidence for designing integrated nutrition and rural health interventions.

Keywords: Correlation analysis, Dairy intake, LSDs, Lifestyle index, Milk consumption, Multi-stakeholder perspective

Milk consumption occupies a paradoxical position within contemporary nutrition debates: while widely promoted for its nutritional benefits, its role in shaping lifestyle-related diseases remains contested across populations and age groups. This ambiguity highlights the need for context-specific evidence that considers dietary behaviour within broader lifestyle patterns rather than in isolation. Lifestyle diseases, largely driven by changes in dietary behaviour, physical inactivity and sedentary living, have emerged as a major public health concern worldwide. Unhealthy daily practices reduce physical activity levels and contribute to the growing prevalence of chronic non-communicable diseases (NCDs), many of which have long-term and potentially life-threatening consequences (Tabish *et al.* 2017). In India, the burden of lifestyle diseases has increased substantially over the past few decades, with their contribution to total disease burden rising from 30.5 per cent in 1990 to 55.4 per cent in 2016 (ICMR, PHFI and IHME, 2017). This rapid epidemiological transition highlights the urgency of addressing lifestyle-related risk factors, particularly in the context of Sustainable Development Goal 3, which emphasizes reducing premature mortality from NCDs through prevention and improved health practices.

Recent national and global estimates further underline the seriousness of the issue. The World Health Organization's Non-Communicable Diseases Progress Monitor 2022 reports that lifestyle diseases accounted for nearly 66 per cent of total deaths in India in 2019, representing over 6 million deaths and a 22 per cent probability of premature mortality. More than one-fifth of adults exhibit elevated blood pressure, signalling a growing risk of cardiovascular diseases, while the burden is further intensified by a rapid increase in diabetes and cancer cases. India currently hosts one of the largest diabetic populations globally, projected to rise from 74 million to 124 million by 2045 (International Diabetes Federation, 2021), and cancer incidence is expected to increase by nearly 12.8 per cent by 2025 (Sathishkumar *et al.* 2022). These trends underscore the importance of examining dietary behaviours and broader lifestyle patterns as potential determinants of health outcomes.

Despite the growing recognition of lifestyle-related health risks, understanding how specific dietary components interact with broader lifestyle patterns remains a critical research gap, particularly in rural and semi-urban Indian

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contexts where nutritional transitions frequently occurring alongside socio-economic change. Milk is an integral component of Indian diets and rural dairy economies, occupies a unique position within this transition. While milk is widely promoted for its nutritional value, its association with lifestyle diseases remains debated, necessitating empirical investigation that considers both dietary intake and overall lifestyle behaviour. Establishing such context is essential for designing balanced nutrition and public health strategies that align dietary practices with disease prevention goals.

Epidemiological and clinical evidence suggest that the relationship between milk consumption and lifestyle diseases is complex and often disease-specific, rather than being uniformly positive or negative. Systematic reviews indicate that dairy intake is associated with a broad spectrum of health outcomes, including cardiovascular diseases, stroke, hypertension, metabolic syndrome, obesity, osteoporosis, type-2 diabetes mellitus and certain neurodegenerative conditions, although excessive intake has been linked with a slightly increased risk of prostate cancer, Parkinson's disease, acne and anaemia in infancy (Zhang *et al.* 2021). Evidences from Indian populations further suggest that an increase of one serving of dairy per day is associated with lower body fat levels and reduced risk of overweight or obesity among adults, whereas higher milk intake among children may increase the likelihood of overweight or obesity, indicating variation across age groups (Satija *et al.* 2013; Lu *et al.* 2016).

With respect to diabetes, several longitudinal and meta-analytic studies report that higher dairy consumption, particularly fermented products such as yoghurt and cheese, is associated with a reduced risk of type-2 diabetes (Malik *et al.* 2011; Tong *et al.* 2011; Thorning *et al.* 2016). Mechanistic evidence suggests that milk proteins may enhance postprandial insulin response while reducing blood glucose levels in both healthy and diabetic individuals and patients with diabetes (Hidayat *et al.* 2019). Similarly, the association between dairy consumption and cancer risk appears heterogeneous: protective effects have been observed for colorectal and breast cancer, increased risk has been reported for prostate cancer, and no consistent associations were identified for several other cancer types (Jeyaraman *et al.* 2019; Ralston *et al.* 2012).

In context of cardiovascular health, meta-analyses and cohort studies indicate a modest inverse association between milk intake and risks of cardiovascular diseases, hypertension and stroke (Soedamah-Muthu *et al.* 2011; Larsson *et al.* 2012). Mendelian randomization evidence further suggest that milk consumption may increase body mass index while simultaneously lowering serum cholesterol levels, reflecting potentially mixed metabolic effects (Vimaleswaran *et al.* 2021). Additional evidence links dairy intake with improved lung function and reduced asthma risk (Hanson *et al.* 2014). Collectively, these findings highlight that the health implications of milk consumption remain inconclusive and context-dependent, reinforcing the need for localized empirical studies that examine dairy intake within broader lifestyle patterns rather than as an isolated dietary factor.

Despite extensive biomedical research across different countries, empirical field-based studies integrating milk consumption, lifestyle behaviour and social context within India remain limited, particularly from a social science perspective. Addressing this gap, the present study explores the relationship between milk consumption and lifestyle diseases through a multi-stakeholder approach, providing contextual evidence from rural and semi-urban settings in Tamil Nadu.

MATERIALS AND METHODS

The study was conducted in Tamil Nadu, India during 2023. Tamil Nadu was purposively selected due to its high level of urbanization (48.4%) and the associated dietary and lifestyle transitions. A cross-sectional ex-post facto research design was adopted to examine existing patterns

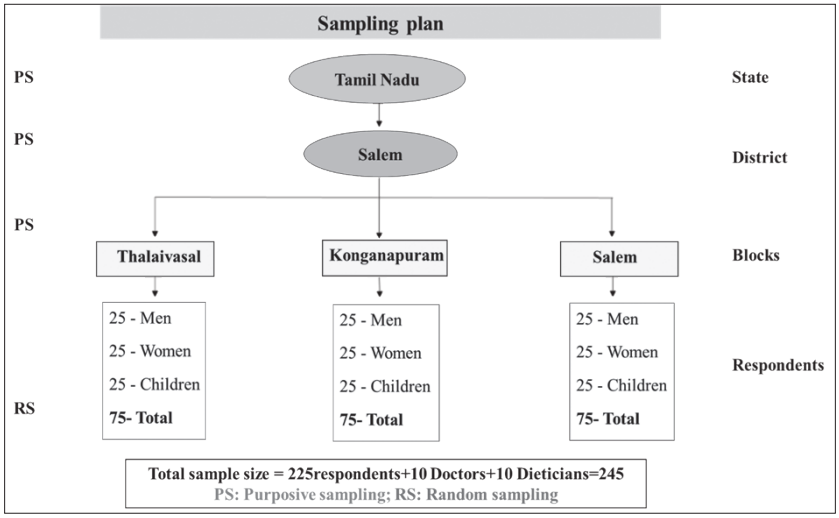

Fig. 1 Sampling plan of the study

Table 1. Distribution of respondents according to milk consumption level among adults and children

Categories	Konganapuram	Salem	Thalaivasal	Overall
	F (P)	F (P)	F (P)	F (P)
No milk consumption	6(12)	0 (0)	1 (2)	7 (4.67)
Less than recommendation (<250 ml)	37 (74)	42 (84)	33 (66)	112 (74.67)
Meeting the recommendation (250-350 ml)	7 (14)	5 (10)	13 (26)	25 (16.67)
Exceeding the recommendation (>350ml)	0 (0)	3 (6)	3 (6)	6 (4)
Total	75 (100)	75 (100)	75 (100)	225 (100)
Children				
No milk consumption	0 (0)	0(0)	0(0)	0(0)
Less than recommendation (<450 ml)	25(100)	25(100)	25 (100)	75 (100)
Meeting the recommendation (450-550 ml)	0 (0)	0 (0)	0 (0)	0 (0)
Exceeding the recommendation (>550)	0 (0)	0 (0)	0 (0)	0 (0)
Total	25 (100)	25 (100)	25 (100)	75 (100)

F – Frequency; P – Per cent

of milk consumption and lifestyle diseases without any experimental intervention by the researchers.

A multi-stage sampling procedure was followed to ensure representation of both rural and urban contexts (Fig. 1).

In the first stage, Salem district was purposively selected because of its leading position in daily milk procurement and sales. In the second stage, three administrative blocks were chosen based on contrasting characteristics: Thalaivasal block (predominantly rural with highest milk production), Konganapuram block (rural with comparatively lower milk production), and Salem block (predominantly urban). This selection enabled comparison between rural and urban populations experiencing different levels of dairy consumption and lifestyle transition. In the final stage, respondents were selected through simple random sampling within each block. A total of 225 individuals were included, comprising 75 men, 75 women and 75 children aged 10–18 years. Thus, the sample represented both rural (Thalaivasal and Konganapuram) and urban (Salem) populations, ensuring diversity in socio-demographic and lifestyle characteristics.

A composite lifestyle index was constructed to assess overall lifestyle behaviour. The index consisted of five sub-indices: Body Mass Index (BMI), physical activity, dietary habits, unhealthy habits, and daily activities. Each indicator was scored based on predefined criteria, and standardized values were aggregated to derive the overall lifestyle index score. The final scores were classified into three categories using the cumulative square root frequency method: unhealthy lifestyle (0.29–0.53), moderately healthy lifestyle (0.54–0.70) and healthy lifestyle (0.71–0.95). Sub-index values were analysed separately to understand the contribution of individual lifestyle components. Individual indicators were first scored on their original scales and subsequently standardized using a normalization procedure to obtain index values ranging from 0 to 1. Indicators representing negative lifestyle behaviour were reverse-coded to maintain directional consistency. Aggregated sub-index values were calculated as the mean of standardized indicators under each dimension.

Lifestyle disease severity was assessed using five parameters: number of diagnosed conditions, perceived risk, duration of illness, severity, and perceived curability. Scores were categorized using the cumulative square root frequency method to maintain consistency with lifestyle index classification.

Primary data were collected through structured personal interviews with respondents during 2023. The interview schedule was pre-tested in Ariyalur district in November 2022 to ensure clarity and reliability. In addition to household respondents, ten medical doctors and ten dieticians were interviewed to obtain expert perspectives on dietary behaviour and lifestyle diseases. Body Mass Index (BMI) was calculated for all respondents using the standard formula BMI = weight (kg) / height (m)² (World Health Organization, 1995). The collected data were coded, tabulated and analysed using descriptive statistics (frequency and percentage) and correlation analysis to examine relationships between milk consumption level, lifestyle index scores and lifestyle disease parameters. Sub-indices of the lifestyle index were also analysed to interpret their individual contribution to overall lifestyle outcomes.

RESULTS AND DISCUSSION

Milk consumption level: For adults, the quantity of milk consumption per day was found to be less than ICMR recommendation (300ml/day) for almost three-fourth of the population (74.67%) as observed from Table 1. Only 16.67 per cent were found to be drinking the recommended milk consumption level. Also, while observing among children (Table 1), it was found that every child (100%) in all the three blocks was found to be consuming less than the recommended milk consumption level which is 500 ml per day as per ICMR recommendations (ICMR-NIN,

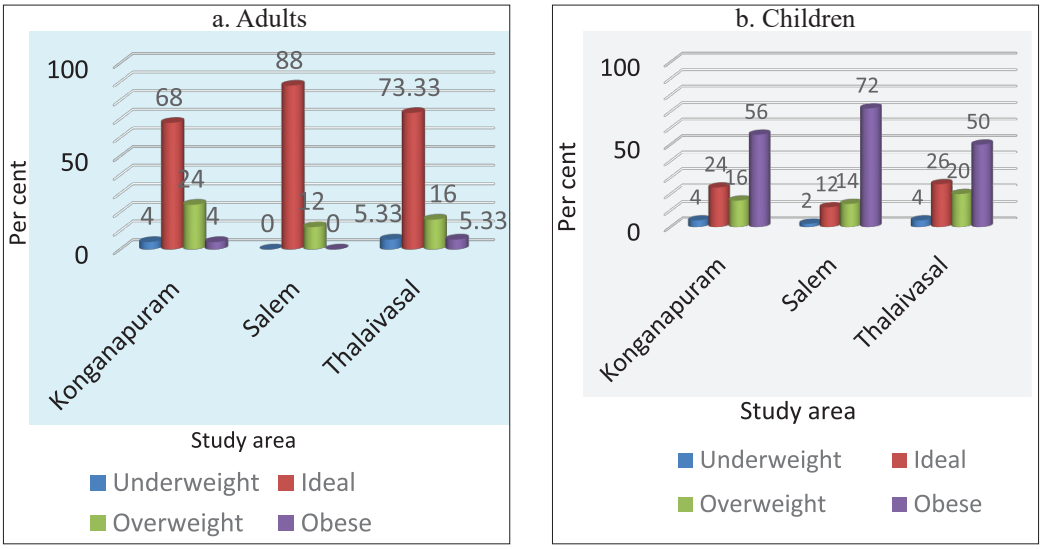

Fig 2. Distribution of respondents according to BMI category among adults and children

2020). Most of the adolescents in India do not meet the recommended level of dairy intake (Gopinath *et al.* 2014). These findings indicate a gap between recommended and actual milk consumption behaviour.

Body Mass Index (BMI): A common use of the BMI is to assess how far an individual's body weight departs from what is normal for a person's height. Upon calculating BMI of the respondents, it was found that more than half of the adults (59.33%) were found to be obese, as seen in Fig 2. The underweight population was found to be negligible (3.33%). According to the District Fact Sheet Salem, Tamil Nadu, 40.3 per cent of women in Salem are overweight or obese (BMI ≥25.0 kg/m^2) whereas 11.2% of women have a BMI below normal (BMI < 18.5 kg/m^2). Among children (Fig 2), almost three-fourth (73.33%) were found to be in the ideal BMI range implying that maximum number of children were adequately nourished in the study area. These findings indicated a potential need for targeted lifestyle interventions among adults.

Lifestyle index and level of lifestyle diseases: Lifestyle of the respondents was studied using the scores of Lifestyle Index. Based on the mean index value the respondents were distributed as shown in Table 4. The lifestyle index distribution indicated heterogeneous lifestyle patterns, with a substantial proportion of respondents falling within unhealthy to moderately healthy categories across the three blocks. Also, from the Table 4, it can be understood that one-third of the respondents were affected by lifestyle diseases like cardiovascular diseases, diabetes, cancer, respiratory ailments, cirrhosis, mental health disorders and critically overweight or obese between a moderate to severe extent. About half (49.33%) of the respondents were less affected by such diseases. The higher proportion of respondents being classified as less affected might be a reflection of early-stage disease conditions or variations in perceived disease severity among participants. Respondents of Salem urban area (42.67%) were found to be affected slightly more to lifestyle diseases as compared to Konganapuram (38.67%) and Thalaivasal (25.33%) blocks. The changes in the lifestyle conditions due to rapid urbanization might be a leading risk factor for the development of these diseases (Munzel *et al.* 2017). Burden of cardiovascular diseases and asthma allergies was found to have a positive association with urban environment (Guarnieri & Balmes, 2014). On contrary, diseases such as diabetes and cancer were found to be associated either positively or without any difference towards urban and rural areas (Flies *et al.* 2019).

Table 2. Mean Index Score obtained for each indicator

Lifestyle Dimension	Sub-Index Value	Lifestyle Interpretation
Body Mass Index (BMI)	0.48	Moderately healthy
Physical Activity	0.54	Moderately healthy
Dietary Habits	0.58	Moderately healthy
Unhealthy Habits *(reverse coded)*	0.04	Unhealthy
Daily Routine	0.56	Moderately healthy
Overall Lifestyle Index	0.44	Unhealthy–Moderate range

The sub-index analysis (Table 2) revealed notable variation across lifestyle dimensions. Dietary habits (0.58), daily routines (0.56) and physical activity (0.54) showed relatively moderate scores, whereas the unhealthy habits dimension recorded a very low index value (0.04), indicating the prevalence of risk-related behaviours such as smoking and alcohol consumption. The comparatively lower BMI index (0.48) further highlighted concerns related to physical health status despite moderate behavioural practices.

One-way ANOVA revealed (Table 3) significant differences among blocks for physical activity ($F = 31.86$, $p < 0.001$), dietary habits ($F = 5.37$, $p = 0.005$) and daily

Table 3. Block-wise Lifestyle Sub-Index Values with One-way ANOVA

Lifestyle Dimension	Konganapuram	Salem (Urban)	Thalaivasal	F-value	p-value	Significance
Body Mass Index (BMI)	0.50	0.45	0.51	0.40	0.668	NS
Physical Activity	0.26	0.73	0.62	31.86	<0.001	***
Dietary Habits	0.52	0.58	0.63	5.37	0.005	**
Unhealthy Habits *(rev.)*	0.03	0.02	0.06	1.42	0.244	NS
Daily Routine	0.54	0.60	0.52	3.36	0.036	*

NS = non-significant; * p<0.05; ** p<0.01; *** p<0.001

Table 4. Distribution of respondents according to lifestyle index scores and lifestyle diseases level

a. Distribution based on Lifestyle index score				
Category (Score)	Konganapuram	Salem	Thalaivasal	Overall
	F (P)	F (P)	F (P)	F (P)
Unhealthy lifestyle (0.29 – 0.53)	40.00 (53.33)	10.00 (13.33)	17.00 (22.67)	67 (29.78)
Moderately healthy lifestyle (0.54 – 0.70)	24.00 (32.00)	37.00 (49.33)	30.00 (40.00)	91 (40.44)
Healthy lifestyle (0.71 – 0.95)	11.00 (14.67)	28.00 (37.33)	28.00 (37.33)	67 (29.78)
Total	75 (100)	75 (100)	75 (100)	225 (100)
b. Distribution based Level of lifestyle diseases				
Less affected (2 – 3.78)	38 (50.67)	35 (46.67)	38 (50.67)	111 (49.33)
Moderately affected (3.79 – 10.34)	29 (38.67)	32 (42.67)	19 (25.33)	80 (35.56)
Severely affected (10.35-17)	8 (10.67)	8 (10.67)	18 (24.00)	34 (15.11)
Total	75 (100)	75 (100)	75 (100)	225 (100)

F – Frequency; P – Per cent

routine scores (F = 3.36, p = 0.036), whereas BMI and unhealthy habit indices did not differ significantly. These findings indicated that behavioural lifestyle dimensions vary spatially across rural and urban contexts.

Relationship between milk consumption level and level of lifestyle diseases: The correlation analysis (Table 5(a)) indicated no significant relationship between milk consumption and lifestyle diseases across Salem (r = 0.062), Konganapuram block (r = 0.039), Salem urban (r = 0.115) and Thalaivasal block (r = 0.050). Similarly, Lago-Sampedro *et al.* (2019) found no association between milk intake and diabetes in Spain, while other studies (Morcillo

Table 5. Correlation between milk consumption level vis-à-vis lifestyle diseases and lifestyle index scores vis-à-vis lifestyle diseases in Salem district

a. Correlation between milk consumption level *vis-à-vis* lifestyle diseases		
Independent variable	Dependent variable	Correlation coefficient (r)
Milk consumption level of Salem district	Level of lifestyle diseases in Salem district	0.062^{NS}
Milk consumption level of Konganapuram block	Level of lifestyle diseases in Konganapuram block	0.039^{NS}
Milk consumption level of Salem urban	Level of lifestyle diseases in Salem urban	0.115^{NS}
Milk consumption level of Thalaivasal block	Level of lifestyle diseases in Thalaivasal block	0.050^{NS}
b. Correlation between lifestyle index scores *vis-à-vis* lifestyle diseases		
Lifestyle Index score of Salem district	Level of lifestyle diseases in Salem district	- 0.29**
Lifestyle Index score of Konganapuram block	Level of lifestyle diseases in Konganapuram block	- 0.22**
Lifestyle Index score of Salem urban	Level of lifestyle diseases in Salem urban	$- 0.27^{NS}$
Lifestyle Index score of Thalaivasal block	Level of lifestyle diseases in Thalaivasal block	- 0.44**

NS- Non-significant, **-Significant at 1% level of significance

et al. 2012; Moreno *et al.* 2015) reported a link between dairy consumption and diabetes. An inverse association was noted between low-fat dairy intake and hypertension risk (Drouin-Chartier *et al.* 2016). However, further clinical studies are needed to establish conclusive evidence.

The correlation analysis (Table 5) revealed a significant inverse relationship between lifestyle index and lifestyle disease incidence, indicating that a higher quality of life is associated with lower disease occurrence. This relationship was significant at the 1 per cent level for the overall data and for rural areas of Konganapuram (r = -0.22) and Thalaivasal (r = -0.44), while it was non-significant for Salem urban (r = -0.27).

Experts' perspective and contextual interpretation: Expert opinions provided additional context to the field-level findings. A majority of experts (80%) considered milk as an essential component of a balanced diet, while nearly 70 per cent acknowledged a potential association between milk consumption and lifestyle diseases, although the direction of this relationship remained unclear. This divergence between expert perception and empirical results highlights the complexity of dietary-health relationships, particularly when behavioural, socio-economic and lifestyle factors interacted simultaneously.

The present study, based on a multi-stakeholder and perception-oriented approach, did not observe a statistically significant relationship between milk consumption levels and lifestyle diseases across the study area. This is in contrast with the earlier systematic reviews and meta-analyses that report protective or inverse associations between dairy intake and certain lifestyle diseases (Zhang *et al.* 2021). Unlike aggregated clinical evidence, the current research reflected the real-world behavioural patterns within the rural and semi-urban Tamil Nadu, where lifestyle practices, awareness levels and socio-cultural factors may mediate dietary effects.

Interestingly, the lifestyle index demonstrated a significant inverse relationship with lifestyle disease incidence, indicating that broader lifestyle patterns including physical activity, dietary behaviour and daily routines may exert a stronger influence on health outcomes than milk consumption alone. The extremely low index value observed for unhealthy habits suggests that behavioural risk factors such as smoking and alcohol consumption play a critical role in shaping disease vulnerability, which may partly explain why milk consumption alone did not show a significant association with lifestyle diseases.

Urban-rural differences further support this interpretation. Respondents from Salem urban area showed relatively higher levels of lifestyle disease burden compared with rural blocks, which may reflect the effects of rapid urbanization, changing work patterns and increased exposure to sedentary environments (Munzel *et al.* 2017). Previous studies have similarly noted positive associations between urban living and cardiovascular or respiratory risks (Guarnieri and Balmes, 2014), although evidence remains mixed for diseases such as diabetes and cancer (Flies *et al.* 2019). These findings emphasize that lifestyle diseases should be examined within a broader socio-behavioural framework rather than attributing risk to a single dietary factor.

Limitations of the study: The findings of the study should be interpreted in light of certain limitations. Firstly, information on milk consumption, lifestyle behaviour and disease severity were based on self-reported responses, which induce recall bias. Secondly, the perception-based design does not establish clinical causality, limiting the ability to draw definitive biomedical conclusions. Thirdly, the relatively small sample size and geographically restricted study area limits the generalizability of findings beyond the study context. Future research integrating clinical measurements with behavioural analysis would provide stronger evidence.

Overall, the study did not find a significant relationship between milk consumption levels and lifestyle diseases among respondents in Salem district. Instead, the findings suggested that the overall lifestyle patterns, as reflected in the lifestyle index, played a more substantial role in influencing disease outcomes. These results contributed to ongoing debates regarding dairy consumption by highlighting the importance of examining dietary practices within a wider lifestyle and socio-cultural context. Future research expanding the geographical scope and incorporating clinical validation can deepen understanding of the complex relationship between diet, lifestyle and health.

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