A COMPARATIVE STUDY OF THE HEALTH STATUS OF YOUNG INDIAN ADULTS INDICATES A POSITIVE IMPACT OF TRADITIONAL INDIAN DIETARY PRACTICES

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Abstract
India is a vast country with diverse food habits, but all the traditional Indian dietary practices consist of grains, pulses, fruits, dairy, and vegetables with or without fish, poultry, and eggs. The benefits of Ayurvedic supplements are well established, contributing to the lowering of various metabolic factors like blood pressure, inflammation, and cholesterol. The COVID-19 pandemic, due to lockdown measures adopted by governments ensured the primary consumption of home-cooked food aligned with the traditional dietary practices of India. While increased consumption of fast food, sugary drinks, snacks, etc. has been correlated with the health parameters of youth in many countries across the world, our study indicates that young adults in India of the age group 17-21 had improved health status after the pandemic-induced isolation. A comparative study of undergraduate students at the University of Delhi was conducted to analyze the impact of the primary consumption of home-cooked traditional food. The health parameters observed in 2023 were compared to a previous study conducted by the group in 2018. As opposed to the global trend, we saw a drop in obesity (based on BMI) from 29% of the subjects in 2018 to 5% in 2023. The subjects with a very high total body fat (TBF) percentage also saw a drop from 34% to 22% for male subjects, and 32% to 26% for female subjects. There was a mild increase in subjects with high visceral adipose tissue (VAT) percentage levels, from 4% in 2023 compared to none in 2018. A spike was also observed in blood pressure (BP). The primary consumption of home-cooked Indian cuisine by participants during the lockdown and increased intake of nutritional and ayurvedic supplements may have led to lower obesity and TBF%. Meanwhile, a sedentary lifestyle and exposure to the SARS-CoV-2 virus may have caused the increase in VAT% and BP respectively. Further studies can carried out to help us better understand the impact of traditional Indian dietary practices on health parameters.

Introduction

Indian diet combines grains, pulses, dairy, fruits, and vegetables, with or without meat/egg options (Salis *et al.*, 2021). The consumption of ayurvedic supplements is a common practice in India, which saw a particular spike during and after the COVID-19 pandemic (The Hindu, November 2021). While the pandemic wreaked havoc across the world and impacted almost all aspects of human life (Chopra *et al*., 2020), it also offered the unique opportunity to study the effects of dietary practices on populations.

Understanding the impact of eating habits and sedentary lifestyle is extremely important, as they contribute to non-communicable diseases (NCDs) such as heart disease, stroke, cancer, diabetes, and chronic lung disease (Malik *et al.,* 2016a). The metabolic risk factors that increase the risk of noncommunicable diseases include raised blood pressure (hypertension), overweight/obesity, hyperglycemia, and hyperlipidemia (Noncommunicable Diseases, WHO). NCDs contribute to around 74% of all deaths globally (WHO, 2014) and about 62% of all deaths in India (PIB, 2022). According to the World Obesity Atlas (UNICEF), India is predicted to have more than 27 million obese children by 2022, representing one in 10 children globally, by 2030 (World Obesity Atlas, 2022). While preventing childhood obesity is a priority, obesity in young adults has been found at alarming levels. Studies indicate that young adults gain weight at a rate faster than any other age group (Cheng *et al.,* 2016).

The debilitating outcomes of a sedentary lifestyle and unhealthy eating habits were further compounded by the pandemic-induced home isolation of people worldwide due to the COVID-19 pandemic. In response to the pandemic, governments worldwide enforced policies that attempted to reduce transmission, by physical distancing measures, also referred to as 'Lockdown' (Chiesa *et al.,* 2021). A poll of adolescents and young people aged 13 to 29 from different countries and territories conducted during the initial days of the lockdown concluded that during the COVID-19 crisis, increased consumption of sugary drinks (35%), snacks and sweets (32%), and fast food and convenience products (29%); and a decrease in consumption of fruits and vegetables (33%) and water (12%) was observed (UNICEF, Latin America and Caribbean).

As expected, this shift in lifestyle affected BMI, obesity, visceral, and body fat percentage globally (Nour and Altintaş, 2023). A direct link between the COVID-19 pandemic and increased obesity in school-aged children has been noted in a New WHO/Europe report (WHO, 2024). In the Republic of China, studies of the youth showed an increase in overweight and obese individuals as a byproduct of the lockdown Yang *et al.*, 2020; Dun *et al*., 2021). The BMI of the average youth was found to increase from 21.8 to 22.1 kg/m^2, with the prevalences of overweight/obesity and obesity increasing from 21.4% to 24.6% and from 10.5% to 12.6%, respectively (Jia *et al*., 2021). A similar increase has been reported in various countries like South Korea (Lee *et al*., 2022), Bangladesh (Akter *et al*., 2022), the United States (USDA, 2022), and the United Kingdom (Zaccardi *et al.,* 2023).

In response to the pandemic, the Indian government also implemented lockdowns to contain the transmission of the virus. The colleges of the University of Delhi, India, were closed accordingly for offline teaching from March 2020 to February 2022. This led to the young adults being home-bound for almost two years, leading to a lifestyle change in them. The prolonged isolation at home enforced by the pandemic led to difficulty in access and consumption of fast food, snacks, and sugary drinks for young Indian adults. As the Indian youth living with parents is the norm (India Today), the restriction of unhealthy food was further applied under the watchful eyes of the parents (Naik *et al.,* 2024).

The current study was carried out to investigate the effect of dietary changes due to the adoption of home-cooked traditional Indian dietary practices (due to pandemic-induced lockdowns), on the health parameters of the students. Our group had conducted a previous study in 2015-16 (Malik *et al.*, 2016a and 2016b) followed by another study in 2018 (unpublished data of Malik *et al.*), to assess the health of the undergraduate students of Shivaji College, University of Delhi. The health assessment was performed by using simple, noninvasive methods during health camps. The BMI of participants was categorized into underweight, normal weight, overweight, and obese (Obesity, WHO). Total Body Fat (TBF) and visceral adipose tissue (VAT) were assessed using Biological impedance analysis (BIA). The blood pressure of participants was also recorded during the 2018 study (unpublished data of Malik *et al.*).

Post-pandemic, in 2023, we assessed the same age group as those of the previous studies, and spending a similar amount of time in college with comparable amounts of activity and consumption of food on campus from similar sources. They had mostly consumed home-cooked traditional Indian food during the pandemic-induced isolation. Hence, a comparison of the health status of students of the same age group as observed before the pandemic (2018, unpublished data of Malik *et al.*, 2015-16, Malik *et al.*, 2016a and 2016b), versus after the pandemic, can shed light on the impact of their diet on their health status. The participants with poor health parameters in current and previous studies had been informed of their health status and recommended to meet the on-campus general physician.

Methodology

Study design and participants

The study was conducted at Shivaji College, a constituent of the University of Delhi, New Delhi, India. A total of 306 students, of the age group 17-21 years, were included in this study. Of them, 112 individuals were females and the rest were males. Data was obtained during Health Camps organized in the college premises January-February, 2023. A questionnaire was created to record the basic details of the participants like age and food preferences (vegetarian, eggitarian, and non-vegetarian). Their consumption of junk food and sugary drinks, intake of nutritional and ayurvedic supplements, and levels of physical activity during the lockdown were also recorded. Responses were also collected regarding Sars CoV 2 infection during the pandemic. The participants were then subjected to anthropometric assessment for various health parameters like BMI, TBF% VAT%, and blood pressure, which were recorded in the questionnaire.

Anthropometric Measurements

The Body Mass Index (BMI), Total Body Fat % (TBF%), Visceral Adipose Fat % (VAT%), Blood Pressure (BP), and pulse rate (PR) of the participants were recorded.

- *Body Mass Index (BMI)*

The calculation of BMI as weight (kg)/square of height (m^2), was conducted by measuring the height and weight of the participants. Their height and weight were recorded using a 2 m height measuring tape and an Equinox digital weighing scale EB 9300, respectively. Weight and height were measured after the removal of shoes while wearing light clothing. The height of the subjects was recorded in a standing position with the shoulders relaxed and the arms hanging freely (Malik *et al.*, 2016a and b). Based on their BMI, the participants were classified as underweight, normal weight, overweight, or obese (Table 1).

Table 1. Standard Values of Anthropometric Measurements Used in the Study

Parameters	Low	Normal	High	Very High
BMI (Kg/m^2)				
All individuals*	< 18.5 Underweight	18.5 - 24.9 Normal weight	≥ 25 Overweight	≥ 30 Obese
Total Body Fat (TBF %)				
Male	<10.0	10.0 - 19.99	20.0 - 24.99	≥25
Female	<20.0	20.0 - 29.99	30.0 - 34.99	≥35
Visceral Fat (cm^2)				
All individuals	0.5-9.5	10-14.5	15.0-30.0	-
Blood Pressure (mm/hg)				
All individuals	<110/70mmHg	110/70-130/90mmHg	>130/90mmHg	-

(Ref: Malik D., Thakur J., Aggarwal J., Dua A., Nijhawan S., Kumar A., Kaur K., Aggarwal H., Mehta D., Verma H., Subhasis, Sheetal, Singh A, Akshay GM and Yadav M. (2016) Quetelet's Index and Body Fat Percentage Assessment in Indian Undergraduate Students. DU Journal of Undergraduate Research and Innovation. Volume 2, Issue 1 pp 56-69)

- *Body Fat measurement (TBF% and VAT%)*

The measurement of body fat (total body fat and visceral fat) was done using the Omron Karada Scan Body Composition Monitor (HBF-375, Omron Health Care Co., Kyoto, Japan). It consists of eight-contact electrodes at an anatomical landmark, namely both footpads and handles. Biological impedance analysis (BIA) analyzers introduce a small electrical current into the body and measure the impedance to current flow. The Omron Karada Scan uses an electrical current of 50 kHz, 500 mA (Jadhav *et al.,* 2022). The instrument works on the principle of biological impedance, which is a successful method for evaluating body composition. It is a relatively simple, quick, non-invasive method. Hence, it is being used widely in various studies involving children as well as adults for the assessment of body composition by a number of healthcare professionals and researchers worldwide. For body fat measurement, it was imperative to begin with entering personal details of each participant such as age, gender and height. The subjects stood barefoot on footplates and grasped the two hand grips with their palms. The posture of the individual was such that the arms were straight with an angle of 90° between the arms and body. Precautions were taken to avoid errors such as shaking of the body, arms too bent, incorrectly positioned feet, and incomplete contact of palms/soles with the electrodes (Malik *et al.*, 2016a and b). The readings for Total Body Fat percentage (TBF%) and Visceral Adipose Tissue percentage (VAT%) were recorded and categorized into relevant categories (Table 1).

Blood Pressure Measurement

Blood pressure was measured using a validated, automated oscillometric device (e.g., Omron HEM-907-Shimogyo ku, Kyoto 600-8530, JAPAN), which records BP oscillometrically with an electrostatic capacity semi-conductor pressure sensor in the range 0–299 mm Hg and heart rates in the range 30–199 beats/min (El Assaad *et al.*, 2002). Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate are displayed on a digital display. The inflation is by an automatic pumping system and the deflation is using an automatic pressure-releasing electromagnetic control valve. If the device is malfunctioning or being used inappropriately, the error codes (from 1 to 9) are indicated.

Measurements were performed according to the following standardized protocol:

- The participant was seated quietly for at least 5 minutes in a chair, with their back supported and feet flat on the floor. The arm was bare and supported at heart level.

- The cuff was wrapped snugly around the participant's bare upper left arm, with the artery marker on the cuff aligned with the brachial artery.

- The device was activated, and the cuff automatically inflated and deflated. The device used the oscillometric method to determine systolic blood pressure (SBP) and diastolic blood pressure (DBP).

- An average of three measurements was recorded for accuracy.

Statistical Analysis

The subjects were grouped according to their anthropometric measurements and body composition parameters. Males and females were also grouped when the parameters showed a gender bias. The present study consisted of a single population of a cross-section of the age group 17-21 years. Basic descriptive statistics for subject data were expressed as mean ± standard deviation.

Results

Health data of undergraduate students of Shivaji College, University of Delhi, India, was collected through health camps conducted in two phases: 2018 and 2023. Various health parameters such as BMI, TBF %, VAT %, and Blood Pressure were measured during the camps. Through this study, we have assessed the health status of the current students and compared them with the data collected previously from students of a similar age group and similar lifestyles (Table 2). This will help us explore the impact of the isolation of almost two years due to the global pandemic of the SARS-CoV-2 virus. The subjects constituted of male and female students, with 54.3% of the female participants.

Table 2: Descriptive characteristics of the sample*

Parameter	All individuals	Males	Females
BMI	22.26 ± 4.11	22.32 ± 3.84	22.09 ± 4.78
TBF %	22.58 ± 8.08	19.4 ± 6.63	29.60 ± 6.64
VAT %	5.29 ± 4.17	5.76 ± 3.85	4.20 ± 4.86
Pulse Rate	94.23 ± 15.33	90.81 ± 14.68	102.31 ± 13.86

*SD standard deviation

The subject population consisted of 46.5% vegetarians, 12% eggitarians and 41.5% non-vegetarians. Only 17.1% of the subjects confirmed to have been infected with Sars CoV 2 virus and had tested positive. The rest were not sure as they had not conducted confirmatory tests.

A. BMI measurement

A comparative assessment of the health data collected from participants before and after COVID-19 was carried out (Figure 1a). The Body Mass Index (BMI) was used as an indicator of the health status of the participants. The data collected in 2018 indicated that 36% of the participants had a normal BMI, 22 % were in the underweight category, 13% were categorized as being overweight and 29% were classified as obese. The health data collected in 2023 indicates that 67% of the participants had a normal BMI, 15% were underweight, 13 % were overweight, and 5 % were obese.
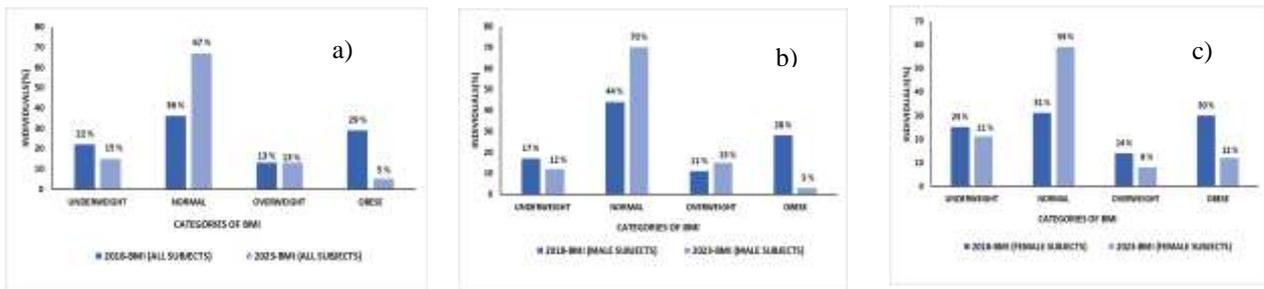
Figure 1. Comparison of the health status of participants of the same age group (17-20) based on their Body Mass Index (BMI), in the years 2018 and 2023. a) Comparison of the BMI of all subjects b) Comparison of the BMI of male subjects. c) Comparison of the BMI of female subjects.

The health status was further categorized based on gender to explore any gender bias on health status. The 2018 study indicates that among the male participants, 17% were underweight, 44% had BMI in the normal category, 11% were overweight, and 28% were obese. In the 2023 study, it was found that 12% of the male subjects were underweight, 70 % were in the normal range, 15 % were overweight and 3 % were obese (Figure 1b). Of the female subjects, in the 2018 study, 25% of participants were in the underweight category, 31% were in the normal range, 14% were overweight and 30% were obese. The 2023 study showed that 21% of the female subjects were in the underweight category, 59% were in the normal range, 8 % were overweight and 12 % were obese (Figure 1c).

B. TBF% Measurement

Body fat is an essential component for the maintenance of basic functions of a system. However lower or higher than normal amounts of Total Body Fat (TBF) can lead to poor health conditions. The normal levels of body fat are higher in women as compared to men. Of the participants of the 2018 study, 20% of male students had a low TBF%, 26%, fell in the normal TBF% range, 19% were categorized as having high TBF% and 34% had very high TBF%. In the 2023 study, it was found that 5% percent of male students had low TBF%, 54% had normal TBF%, 19% were categorized as having high TBF%, and 22% were categorized as having very high TBF% (Figure 2a).

In 2018, a negligible number of female students (2%) had a low TBF%, 47% fell in the normal TBF% range, 17% were categorized as having high TBF%, and 32% were labeled as having very high TBF%. However, in 2023, the percentage of female students with low TBF% was found to be 9%, the percentage of female students with normal TBF% was 46%, the female participants (Figure

2b) categorized as having high TBF% was 18%, and those with very high TBF% consisted of 26% of female students.
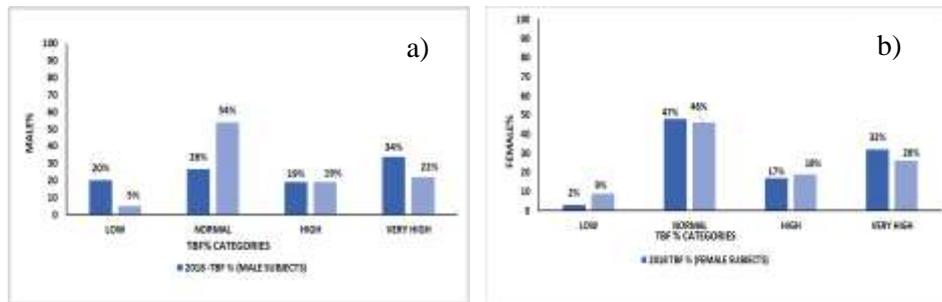
Figure 2. Comparison of the health status of participants of the same age group (17-20) based on their total body fat percent (TBF%). a) Comparison of the TBF% of male participants. b) Comparison of the TBF% of female participants.

C. VAT% measurement

High or low levels of Visceral Adipose Tissue (VAT) can harm the body. The 2018 study showed that 98% of the participants had a low VAT%, only 2% were found to have normal VAT%, and none of the participants were found to lie in the high VAT% category. In the 2023 study, it was found that 87% of the participants belonged to the low VAT% category, 9% had normal VAT% and 4% of the participants had a high VAT% (Figure 3a).
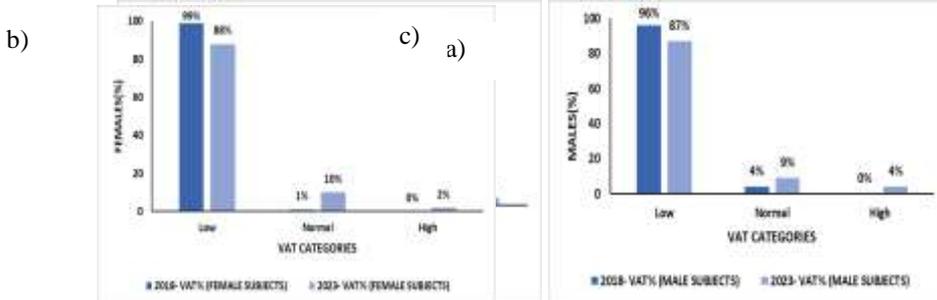
Figure 3. Comparison of the health status of participants of the same age group (17-20) based on their Visceral Adipose Tissue Percent (VAT%), in the years 2018 and 2023. a) Comparison of the VAT% of all subjects b) Comparison of the VAT% of male subjects. c) Comparison of the VAT% of female subjects.

Upon segregation of the data based on gender, the 2018 study showed that amongst the male participants, 96% lay in the low VAT% category, 4% in the normal category, and none of the male subjects belonged to the high VAT% category. In the 2023 study, it was found that 87% of the male participants lay in the low VAT% category, 9% in the normal category, and 4% of the male subjects belonged to the high VAT% category (Figure 3b).

In the case of the female subjects, it was found that the 2018 study had 99% participants in the low VAT% category, and 1% in the normal VAT% category. In the 2023 study, 88% of the female

subjects belonged to the low VAT% category, 10% belonged to the normal VAT% category and 2% were categorized to have high VAT% (Figure 3c).

D. BP measurement

Hypertension is considered to be a major indicator of heart disease. A comparison was made on the percentage of blood pressure (BP) among all subjects. (Figure 4a-c) In 2018, a vast majority of students, accounting for 44%, had normal BP, indicating a healthier body composition. Only a few 16% of students fell into the high BP range, while the rest 40% were categorized as having low BP. However, fast forward to 2023, and there has been a noticeable shift. The percentage of students with low BP decreased to 26%, showing a slight flourish in overall health. Meanwhile, the percentage of students with high BP rose to 38%, signifying a noteworthy increase. Additionally, a concerning 36% of students were categorized as having normal BP, and an 8% decline in health which may warrant attention and interventions to promote healthier lifestyle choices. Therefore, it was found that there was a negative shift in health outcomes from 2018 to 2023, as there was a decrease in the percentage of students with low and normal BP and an increase in the percentage of students with high BP.
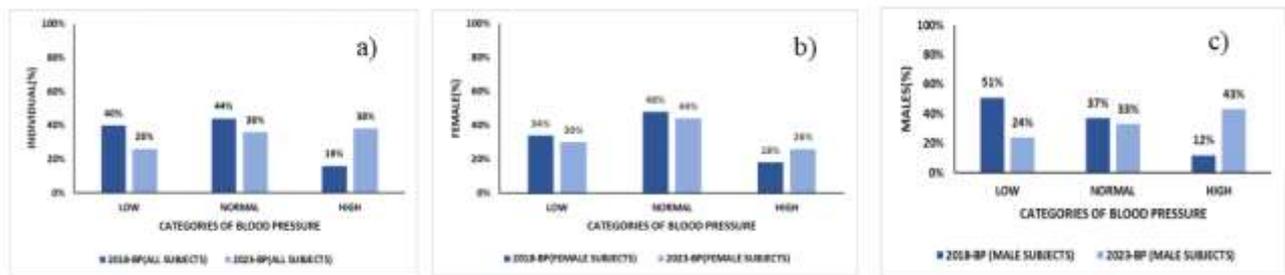
Figure 4. Comparison of the health status of participants of the same age group (17-20) based on their Blood Pressure (BP), in the years 2018 and 2023. a) Comparison of the BP of all subjects b) Comparison of the BP of female subjects. c) Comparison of the BP of male subjects.

Discussion

Studies show that Indian youth tend to consume more junk food when meeting with friends (70.7%) as compared with family (13.8%) (Naik *et al.,* 2024). The SARS CoV-2 pandemic led to almost 2 years of home isolation with family for the Indian youth. As conveyed by the participants of this study as well as data collected by other groups, it is evident that the subjects of the age-group 17-21 consumed meals that were in alignment with the traditional Indian dietary practices. It was also found that most of our subjects took traditional Ayurvedic supplements during the pandemic and many of them continued thereafter.

Our previous studies showed that a surprisingly high number of undergraduate students in Delhi were found to be unhealthy with high BMI, obesity, TBF %, VAT %, and blood pressure. This is in congruence with Indians being predicted to have more than 27 million obese children by 2022 (World Obesity Atlas, UNICEF), and a reported 62% of all deaths in India being related to NCDs (PIB, 2022). Almost two years of online teaching during the pandemic from 2020 to 2022 led to enforced home isolation of these young adults. Globally, this led to prolonged inactivity, an increased consumption of sugary drinks, sweets, and fast food; and reduced fruit and vegetable

intake. This led to poorer health status in young adults, reflecting higher rates of BMI, obesity, body fat percentage, and hypertension in many countries.

Surprisingly, we saw a drop in obesity (based on BMI) from 29% of the subjects in 2018 to 5% in 2023, with a higher drop in males as compared to females (9.3X reduction in males, as compared to 2.5 X reduction in females). The subjects with very high total body fat (TBF) percentage also saw a drop from 34% to 22% for male subjects, and 32% to 26% for female subjects. However, our study also found a mild increase in the number of subjects with high levels of VAT%, from none in 2018 to 4% in 2023. While the same trend was observed in male subjects, the female subjects showed a sharper rise than the males. A spike was also observed in blood pressure (BP), with an overall 2.3X increase in the percentage of individuals with high BP, with a gender bias (males showed a 3.58 X increase, while females showed a 1.44 X increase).

The primary consumption of home-cooked Indian cuisine may have contributed to healthier eating habits leading to a decline in obesity and TBF. The global trend shows that an increase in consumption of sugary drinks and fast food occurred in the youth; and a decrease in the consumption of fruits and vegetables. In contrast, the subjects of our study have been reported to maintain a healthier diet during the lockdown than before. There was an increase in the consumption of milk, fresh fruits, cereal, pulses, and vegetables. Concomitantly the consumption of processed foods and junk food was highly reduced as compared to pre-lockdown times. Similar observations have also been noted by other studies conducted on Indians (Nirala *et al.,* 2022; Motiwala *et al.,* 2023).

Our study also found that almost all participants had consumed some form of Ayurvedic/nutritional supplements during the lockdown. The Ministry of Ayush, India, specifically alerted states and union territories to augment general immunity by taking traditional supplements. The consumption of Ayurvedic medicines/products increased more than double-fold (from ₹26.73 crore to ₹69.60 crore) during the COVID-19 pandemic with the Indian Medicines Pharmaceuticals Corporation Limited (IMPCL), a government enterprise and manufacturer of Ayurveda and Unani medicines (The Hindu, November 2021). This may also have been responsible for the overall improvement in health parameters like obesity and total body fat percent (TBF %) observed in our subjects. The increase in the VAT % may have occurred due to indoor confinement and less physical activity leading to a sedentary lifestyle. A vast number of Indians were Covid-19 positive during the pandemic, and it is believed that the actual number of infections is underreported (Liu *et al.,* 2024; Shankar *et al.,* 2022). Exposure to the SARS-CoV-2 virus may have led to increased blood pressure (Akpek 2021; Schmidt-Lauber *et al.,* 2023).

Thus, through this study, it can be deduced that traditional Indian dietary practices are primarily healthy and enforced home isolation led to the adoption of healthier food options by the Indian youth. The role of ayurvedic supplements in supporting better health in terms of obesity and body fat needs further investigation. Further studies may help explore the health benefits of Indian food habits. Unlike the prolonged and extensive studies conducted on the impact of Mediterranean and other dietary practices (Malik *et al.*, 2023), further research is required to assess Indian dietary practices. The marked increase in Blood Pressure in the subjects (perhaps due to exposure to SARS CoV 2) is a matter of great concern as early-onset hypertension may be an indicator of future cardiac diseases in young adults. The authors strongly feel that large surveys need to be undertaken to understand the extent and significance of early-onset hypertension. This is particularly so as the age group of 17-21 does not monitor blood pressure traditionally. Hence, it is of paramount importance to understand the situation better and adopt appropriate measures by the individual and state.

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