Temporal Trends in Obesity and Chronic disease risks among Young Adults: a 10-year Review at a Tertiary institution, Nigeria

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Abstract

Background

There is an increasing prevalence of obesity among college/university students in developing countries similar to the trend being observed in industrialized countries. Of great concern is the persistence of weight gain among this young population with the risk of being overweight and obese increasing with years of study and till adulthood. The aim of this study is to describe the trend and burden of overweight/obesity and emerging associated chronic disease risks among adolescents and young adults at the University of Ibadan, Nigeria.

Method

This is a 10-year retrospective review of medical records of students (undergraduate and post-graduate) admitted between 2009 and 2018 at the University of Ibadan, Nigeria. A total of 60,168 participants were analysed. The Body mass index (BMI) categories were determined according to WHO standard definitions and blood pressure was classified according to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC7)

Result

The mean age of the study participants was 24.8, SD 8.4 years. A large majority was ≤ 40 years (95.1%). There was a slight male preponderance (51.5%) with a male to female ratio of 1.1:1; undergraduate students constituted 51.9%. The prevalence of BMI categories was underweight (10.5%), overweight and obesity 18.7% and 7.2% respectively. We found significant association between overweight/obesity and older age, being female and undergoing postgraduate study (p = 0.01). Furthermore, females had a higher burden of coexisting abnormal BMI characterized by co-occurrence of underweight, overweight and obesity. Hypertension was the most prevalent obesity-associated non-communicable disease in this study with a prevalence of 8.1%. Also, a third of the study population (35.1%) had prehypertension. Hypertension is significantly associated with age, male sex, overweight/obesity and family history of hypertension. Other rare obesity-associated diseases include asthma, diabetes, dyslipidemia, osteoarthritis and gallstones.

Conclusion

This study identified rising trends in the prevalence of obesity, a double burden of malnutrition among the study population and the emergence of non-communicable disease risks with a lifelong implication on their health and concomitant burden on the healthcare system. Cost-effective interventions are urgently needed at the secondary and tertiary-level educational institutions to address these issues.

Background

Over the past two decades, dramatic increases have occurred globally in the prevalence of obesity in both children and adults [1, 2]. The prevalence of obesity in children and young adults has steadily increased to epidemic proportion in industrialized nations and the same trend is being observed in Low- and Middle-Income Countries (LMIC) [3, 4, 5]. The increasing trend of obesity among children and young adults, especially college and university students, is becoming alarming. In the USA and UK, estimates of the prevalence of being overweight or obese among young adults range from 22 to 35 % [6, 7, 8]. Similarly, among university students in LMIC, the prevalence of overweight/obesity is reported to be 10–20.7% in Nigeria [9, 10], 10.8–24% in South Africa [11, 12],11–37.5% in India [13, 14] and 20–30% in Malaysia [15, 16].

Of great concern is the persistence of weight gain beyond the first year (freshman year) with the risk of being overweight and obese increasing as the year of study increases and till later adulthood. In other words, once established, childhood and adolescent obesity status conferred markedly heightened risks for later overweight and obesity [17, 18]. Thus,
overweight and obesity in adolescents and young adults have important public health implications, not just about its increasing prevalence, but because of possible long-term associations with future weight status and related morbidity. Also, while diseases associated with under-nutrition are still a major issue, LMIC are experiencing a marked increase in overweight and obesity associated with rising burden of non-communicable diseases (NCDs). This dual burden of malnutrition places heavy tolls on individuals, families, economies and health-care systems [19, 20] in terms of cost of treatment and mortality.

The causes of excess weight gain in young people are similar to those in adults. However, young people are significantly prone to obesity due to changes during the transition from childhood/adolescence to adults [17, 21], accompanied by the peculiar and significant lifestyle changes that occur during the phase of leaving home and going to university/college [22, 23]. The interaction of social, psychological and biological factors that happen during these transition years, added to the pervading obesogenic environment make them vulnerable to many risk-taking behaviours [24, 25, 26]. For example, there is preference for energy-dense foods, higher-fat intake and more consumption of sugar-containing drinks. Reduced energy expenditure due to not getting enough physical activity, sedentary activities such as long hours of watching television or other screen devices are also contributory factors in an increasingly urbanized and digital world. The transition to independence of college students, the competing academic demands in the presence of unhealthful lifestyle options and existing environments that greatly favour high energy intake and low energy expenditure provide the complex mix perpetuating the obesity trajectory in the campuses [27].

The rising prevalence of overweight and obesity and lack of physical activity contributes to increasing risks of various chronic diseases in young adults with greater severity in adulthood. Studies showed that risk factors for metabolic syndrome are more prevalent among overweight or obese children and young adults than among those of healthy weight [28, 29]. Obesity in childhood or adolescence is associated with higher risk of adult hypertension, coronary heart disease, and stroke [30]. Thus, the increasing prevalence of overweight and obesity among adolescents may be leading to a higher young adult hypertension prevalence that will continue into the future with severe complications. There is a concern that overweight/obesity and associated chronic diseases such as hypertension, Cardiovascular Disease (CVD) and diabetes are fast emerging as the most prevalent NCDs in LMIC prematurely affecting younger people.

The university environment presents a unique opportunity to target young persons for obesity prevention interventions. The period of stay of young people in the university also offers many opportunities for relevant longitudinal prospective studies and life courses. However, young adults are largely overlooked due to the perception that many in this population are at a low risk of developing chronic diseases. At present, there are limited data to show the temporal trends in the pattern of transition and prevalence of overweight/obesity among university students in Nigeria. Furthermore, there is no evidence of any concerted efforts at stemming the tide of the epidemic. It may as well be that Nigerian universities are unwittingly sustaining obesogenic environment critical to amplifying the biologic vulnerability of young people to obesity. Unlike substance abuse and mental health issues, many college and university leaders may view helping overweight and obese students as being outside the purview of higher education [27]. This may explain why there has not yet been any recorded obesity prevention interventions being conducted in developing countries within or for this age group ([31]. The aim of this study was to identify and describe the burden of overweight/obesity and chronic disease risks among young adults in University of Ibadan (UI), Nigeria with a view to laying the foundation for a sustainable plan that promotes optimal weight management and future research in obesity prevention and intervention in the institution.

**Methods**

**Study design**

This was a 10-year retrospective review of medical records of students (undergraduate and post-graduate) admitted between 2009 and 2018 in UI. The study participants consisted of adolescents and young adults who were enrolled as
freshmen for undergraduate studies and those who had returned or enrolled for postgraduate studies in the institution. The medical record review utilized the data of students admitted for each new academic year under review. It consisted of data from the screening routinely done at inception as part of their admission processes and the follow-up data comprised information on any obesity-related diseases that they obtained treatment and care for at the University Health Services (UHS). In this study, adolescent and young adults were classified as those from 16 to 40 years of age while those above 40 years and ≤ 65 years were classified as adults (middle age and older adults).

**Study setting**

UI was established in 1948 and it is located five miles (8 kilometres) from the centre of the major city of Ibadan in South-Western Nigerian. It currently runs academic programmes in sixteen Faculties and other academic units among which are: Institute of Child Health, Institute of Education, Institute of African Studies. Also, the University plays host to the Pan African University which runs postgraduate studies.

Each academic year, new students admitted for undergraduate and postgraduate programmes are required to register at the UHS as part of the admission process and for their medical care during their stay in the university. The UHS employs structured questionnaires to collect pre-admission health information including socio-demographic characteristics and background medical (personal and family) history of the students. Physical examination and measurements including pulse rate, blood pressure (BP), height, weight and BMI are also carried out. For this population, the body mass index was derived using the weight and height measures. Weight was measured to the nearest 0.1 kg using a digital scale. Height was measured to the nearest 0.1 cm with a portable stadiometer while the individual stood barefoot on the centre of the base with their back to the stadiometer. The BMI was calculated by body weight (kg) divided by squared height (m2). The BMI was then split into 4 categories: underweight (BMI < 18.5), normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9) and obesity (BMI ≥ 30) [WHO, 1995]. Blood pressure was measured using a mercury sphygmomanometer based on the recommended standards [32] and classified according to JNC 7 [33]. Chest x-ray and urinalysis were carried out as part of the initial medical evaluation. All these and the medical records of subsequent visits by each student to the clinic were documented in the clinic personal file. Information about diagnosis and treatment for obesity-related diseases such as hypertension, diabetes, dyslipidemia, asthma, gall stones were extracted and reviewed retrospectively. Also, the results of relevant investigations such as Electrocardiography (ECG) and lipid profile were reviewed, where available.

**Study population**

A total sample consisting of all the medical records during the period of review was collected. Specifically, all the health records of the newly admitted students during the 10-year period of review (2009-2018) were used for this study. The University offered admission to an average of 3,500 undergraduate students and 3,000 of postgraduate students for each year of admission during the period of review. Therefore, a total sample of approximately 60,168 medical records with complete information was used for this study. The data presented in this study depicts the profile of a large population of young people from different regions of Nigeria.

**Data collection**

From June through October 2020, medical records were extracted by trained Research assistants using a standardized excel tool. The outcome variables of interest are overweight and obesity and the covariates are age, sex, background medical (personal and family) history of the students (hypertension, diabetes, asthma, medications), treatment records for obesity-related diseases such as hypertension, diabetes, dyslipidemia, asthma, gall stones and cancers.

**Data analysis**
The data was entered and cleaned using SPSS 21. Numerical variables such as age, weight, height and blood pressure were summarized using mean (SD) while frequencies/percentages were used for categorical variables. Trends in obesity and hypertension were assessed using Chi square for trend at 5% significance level. Independent factors associated with obesity/overweight and hypertension were assessed using multivariable binary logit model. Measures of effect were reported as Odds Ratio with 95% Confidence Interval (95% CI).

**Ethical Consideration**

This is a retrospective medical record review only with no contact with human subjects. Permission to access and use data from the medical records was obtained from the Management of the University of Ibadan Health Services. All information extracted from the medical records were recorded without identifiers and kept confidential. The need for informed consent was waived by the Social Sciences and Humanities Research Ethics Committee (SSHREC), University of Ibadan, Nigeria. The study was conducted in accordance with the National Code of Health Research Ethics, Nigeria which is in accordance with the Declaration of Helsinki guidelines. Ethical approval for this study was provided by the Social Sciences and Humanities Research Ethics Committee (SSHREC), University of Ibadan, Nigeria [UI/SSHEC/2020/0021].

**Results**

**Background characteristics**

Table 1 shows the trends in socio-demographics (age group, sex, programme, BMI and hypertension) of students between 2009 and 2018. A large majority was ≤ 40 years (95.1%). Students aged 16–20 years constituted at least a quarter during the years under review. In addition, the percentage in this age group has been on the increasing trend since 2013 till 2018 while the reverse pattern was observed for age 36 years and above of which their percentage declined. The sex distribution was in favour of males between 2009 (51.5%) and 2011 (53.7%) but this has been reversed thereafter such that males constituted less than 50% since 2015. Overall, undergraduate students constituted 51.9% of the entire sample. However, there were some variations over time with a lowest value in 2011 (35.8%) and highest in 2017 (68.1%) and 2018 (65.8%).
Table 1

Socio-demographic characteristics of students at each year of entry at the University of Ibadan from 2009–2018

| Variables                      | Overall (%) | 2009 (%) | 2010 (%) | 2011 (%) | 2012 (%) | 2013 (%) | 2014 (%) | 2015 (%) | 2016 (%) | 2017 (%) | 2018 (%) |
|--------------------------------|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| n = 59732                      | n = 5739    | n = 6726 | n = 6630 | n = 7288 | n = 5949 | n = 5146 | n = 6314 | n = 5259 | n = 4860 | n = 5821 |

**Age-group (years)**

| 16–20  | 39.2 | 34.8 | 33.1 | 27.8 | 25.0 | 34.9 | 43.9 | 42.8 | 49.9 | 56.4 | 53.8 |
| 21–25  | 24.5 | 23.7 | 21.5 | 17.3 | 22.3 | 28.4 | 24.7 | 31.3 | 28.0 | 25.8 | 23.8 |
| 26–30  | 19.2 | 18.8 | 22.5 | 27.7 | 26.9 | 20.5 | 17.3 | 15.4 | 13.9 | 10.1 | 13.3 |
| 31–35  | 7.9  | 10.1 | 9.6  | 12.6 | 11.4 | 7.7  | 7.2  | 5.4  | 3.9  | 3.3  | 4.7  |
| 36–40  | 4.4  | 6.4  | 6.6  | 6.6  | 6.7  | 4.1  | 3.3  | 2.5  | 2.2  | 2.1  | 1.9  |
| 41+    | 4.9  | 6.2  | 6.7  | 6.7  | 7.6  | 4.4  | 3.6  | 2.7  | 2.0  | 2.2  | 2.5  |

**Sex**

|   | Male (%) | 51.5 | 52.4 | 53.5 | 53.7 | 44.4 | 52.2 | 51.1 | 49.8 | 45.8 | 49.1 | 49.1 |
|---|----------|------|------|------|------|------|------|------|------|------|------|------|
|   | Female (%) | 48.5 | 47.6 | 46.5 | 46.3 | 55.6 | 47.8 | 48.9 | 50.2 | 54.2 | 50.9 | 50.9 |

**Programme**

|   | Undergraduate (%) | 51.9 | 53.3 | 48.8 | 35.8 | 33.6 | 49.8 | 58.1 | 55.6 | 61.3 | 68.1 | 65.8 |
|---|------------------|------|------|------|------|------|------|------|------|------|------|------|
|   | Postgraduates (%) | 48.1 | 46.7 | 51.2 | 64.2 | 66.4 | 50.2 | 41.9 | 44.4 | 38.7 | 31.9 | 34.2 |

**Anthropometrics and hypertension profile**

Overall, 10.5% of students were underweight and the average trend has remained around this level over time [see Fig. 1]. The prevalence of overweight and obesity was 18.7% and 7.2% respectively (Table 2). Over time, overweight prevalence ranged between 23.0% in 2009 and 13.4% in 2017 though with no clear upward or downward trend. Similarly, the percentage of obese individuals ranged between 9.2% in 2012 and 5.0% in 2014 with no clear pattern of increase or decrease [See Fig. 2]. With regards to sex distribution, there were more underweight, overweight and obese females compared to males [see Fig. 3].

The prevalence of hypertension based on systolic (140) and diastolic (90) blood pressure cut-off at enrolment was 8.1%. The level seems to be on a downward trend since 2015 (11.4%) till 2018 (5.5%) [see Fig. 4].
| Variables | Overall | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|-----------|---------|------|------|------|------|------|------|------|------|------|------|
| n (%)     | n (%)   | n (%)| n (%)| n (%)| n (%)| n (%)| n (%)| n (%)| n (%)| n (%)| n (%)|
| BMI       |         |      |      |      |      |      |      |      |      |      |      |
| Underweight | 6311  | 331  | 584  | 598  | 563  | 659  | 692  | 905  | 627  | 751  | 619  |
|           | (10.5) | (5.8)| (8.7)| (9.0)| (7.7)| (11.1)| (13.2)| (14.2)| (11.9)| (15.5)| (10.6)|
| Normal    | 38038  | 3527 | 4339 | 3919 | 4468 | 3953 | 3466 | 3866 | 3581 | 3240 | 3877 |
|           | (63.5) | (62.1)| (64.4)| (59.1)| (61.2)| (66.0)| (66.2)| (60.7)| (68.2)| (66.7)| (66.5)|
| Overweight | 11186  | 1304 | 1313 | 1464 | 1599 | 993  | 817  | 1127 | 772  | 652  | 945  |
|           | (18.7) | (23.0)| (19.4)| (22.1)| (21.9)| (16.7)| (15.6)| (17.7)| (14.7)| (13.4)| (16.2)|
| Obese     | 4339   | 517  | 506  | 649  | 672  | 375  | 260  | 470  | 272  | 216  | 385  |
|           | (7.2)  | (9.1)| (7.5)| (9.8)| (9.2)| (6.3)| (5.0)| (7.4)| (5.2)| (4.4)| (6.6)|
| Mean ± SD | 23.76 ± | 23.20 ± | 23.61 ± | 23.61 ± | 22.70 ± | 22.34 ± | 22.42 ± | 22.68 ± |
|           | 4.40    | 4.40  | 4.41  | 4.19  | 4.09  | 6.07  | 5.32  | 4.40  |
| Hypertension |       |      |      |      |      |      |      |      |      |      |      |
| Yes       | 4851   | 476  | 556  | 624  | 419  | 483  | 441  | 723  | 444  | 362  | 323  |
|           | (8.1)  | (8.3)| (8.3)| (9.4)| (5.7)| (8.1)| (8.6)| (11.5)| (8.5)| (7.4)| (5.5)|
| No        | 54894  | 5273 | 6170 | 6005 | 6874 | 5465 | 4706 | 5589 | 4809 | 4503 | 5498 |
|           | (91.9) | (91.7)| (91.7)| (90.6)| (94.3)| (91.9)| (91.4)| (88.5)| (91.5)| (92.6)| (94.5)|

**Medical history and obesity-related health conditions**

Table 3 shows the medical history and obesity-related health conditions or disease profile of the students. Over the 10-year period, hypertension is the most prevalent non-communicable disease which is followed by asthma. Thirty five percent of the study population had pre-hypertension defined as systolic pressure from 120 to 139mmHg or diastolic pressure from 80 to 89mmHg. About 2.2% of the study population had multiple risk factors for hypertension. The multiple risk factors identified in the data include age, male sex, family history of hypertension, overweight and obesity. Other rare but associated diseases include diabetes, dyslipidemia, osteoarthritis and gallstone. Only about a fifth of those with a diagnosis of hypertension had Electrocardiography (ECG) done as part of their evaluation. About 75% of the ECG result revealed Left Ventricular Hypertrophy (LVH). In terms of intervention, only about a tenth (10.9%) of those who met criteria for a hypertension diagnosis had records of follow-up treatment. On the other hand, almost all the study participants with diagnosis of asthma (97.9%) and diabetes (91.7%) had records of follow up treatment.
### Table 3
Medical history and obesity-related disease profile of students attending University of Ibadan Health Centre from 2009–2018

| Variables                                      | Frequency | Percentage |
|------------------------------------------------|-----------|------------|
| **Family History of Hypertension**            |           |            |
| Yes                                           | 3416      | 4.3        |
| No                                            | 56187     | 95.7       |
| **Family History of Diabetes**                |           |            |
| Yes                                           | 2548      | 4.3        |
| No                                            | 57051     | 95.7       |
| **Hypertension**                              |           |            |
| Cases at entry                                | 4851      | 96.4       |
| New cases at clinic visit                     | 183       | 3.6        |
| **Hypertension cases on follow-up treatment (n = 5034)** |   |            |
| Yes                                           | 546       | 10.9       |
| No                                            | 4488      | 89.1       |
| **Diabetes**                                  |           |            |
| Yes                                           | 48        | 0.1        |
| No                                            | 60115     | 99.9       |
| **Diabetes cases on follow-up treatment (n = 48)** |   |            |
| Yes                                           | 44        | 91.7       |
| No                                            | 4         | 8.3        |
| **Dyslipidemia**                              |           |            |
| Yes                                           | 60156     | 100.0      |
| No                                            | 432       | 0.7        |
| **Asthma**                                    |           |            |
| Yes                                           | 59530     | 99.8       |
| No                                            |           |            |
| **Asthma cases on follow-up treatment (n = 432)** |   |            |
| Yes                                           | 423       | 97.9       |
Variables & Frequency

| Variables              | Frequency | Percentage |
|------------------------|-----------|------------|
| No                     | 9         | 2.1        |
| Gallstone              | 6         | 0.0        |
| Yes                    | 60157     | 100.0      |
| No                     | 26        | 0.0        |
| Osteoarthritis         | 60137     | 100.0      |
| Yes                    |           |            |
| No                     |           |            |
| Pre-hypertension (denominator excludes hypertensives) | 20959 | 35.1 |
| Multiple HTN risk factors | 1315   | 2.2        |
| Chest xray             |           |            |
| Normal                 | 59430     | 99.5       |
| Abnormal               | 302       | 0.5        |
| ECG (n = 282, 5.6%)    |           |            |
| Normal                 | 72        | 25.5       |
| Abnormal (LVH)         | 210       | 74.5       |

**Association between the socio-demographic characteristics of the students and overweight/obesity**

There is significant association between age and overweight/obesity (Table 4). The percentage of students that are overweight or obese increased as age increases except with students above 41 years who had lower percentage of overweight and obese students compared to those between ages of 31 to 40 years. There is also significant association between gender and being overweight or obese with more female students being overweight or obese (30.9%) than male students (21.2%). More postgraduate students were overweight or obese (37.8%) compared to undergraduates (15.0%).

| Variables                        | Overweight & Obesity | X²         | p-value |
|----------------------------------|----------------------|------------|---------|
|                                  | Yes (%)              | No (%)     |         |
| **Age-group**                    |                      |            |         |
| 16-20 years                      | 3298 (14.0)          | 20244 (86.0)| 6321.219| 0.001   |
| 21-25 years                      | 3278 (22.3)          | 11406 (77.7)|         |         |
| 26-30 years                      | 3582 (31.2)          | 7900 (68.8) |         |         |
| 31-35 years                      | 2039 (43.6)          | 2635 (56.4) |         |         |
| 36-40 years                      | 1437 (54.8)          | 1187 (45.2) |         |         |
| 41+                              | 1884 (66.4)          | 955 (33.6)  |         |         |
| **Sex**                          |                      |            |         |
| Male                             | 6545 (21.2)          | 24282 (78.8)| 730.243| 0.001   |
| Female                           | 8980 (30.9)          | 20067 (69.1)|         |         |
| **Programme**                    |                      |            |         |
| Undergraduate                    | 4674 (15.0)          | 26458 (85.0)| 4023.587| 0.001   |
| Postgraduates                    | 10851 (37.8)         | 17891 (62.2)|         |         |

Table 4: Bivariate analysis showing the association between socio-demographics characteristics of students Overweight & Obesity
The factors that were identified to be significantly related to overweight/obesity were also subjected to multivariate analysis the results of which are presented on table 5. The likelihood of overweight/obesity increased with age. For instance, students aged 36-40 years (OR=5.27) and aged 41 years and above (OR=8.96) were more likely than those aged 16.-20 years to be overweight/obese. The odds of overweight/obesity were significantly higher among females than males and postgraduate students [see Table 5].

Table 5: Multivariate analysis showing the association between socio-demographics characteristics of students and Overweight and Obesity

| Variables   | Odd-ratio | p-value | 95 %Confidence Interval (Odd ratio) |
|-------------|-----------|---------|------------------------------------|
| Age-group   |           |         |                                    |
| 16-20 years | ref       |         |                                    |
| 21-25 years | 1.30      | 0.001   | 1.21                               |
| 26-30 years | 1.94      | 0.001   | 1.78                               |
| 31-35 years | 3.39      | 0.001   | 3.08                               |
| 36-40 years | 5.27      | 0.001   | 4.72                               |
| 41+         | 8.96      | 0.001   | 8.01                               |

| Sex          |           |         |                                    |
|--------------|-----------|---------|                                    |
| Male         | ref       |         |                                    |
| Female       | 2.12      | 0.001   | 2.04                               |

| Programme    |           |         |                                    |
|--------------|-----------|---------|                                    |
| Undergraduate| ref       |         |                                    |
| Post-graduate| 1.63      | 0.001   | 1.52                               |

Association between the socio-demographic characteristics and prehypertension and hypertension

Table 6 shows the bivariate association between socio-demographics characteristics of students, prehypertension and hypertension. There was a significant association between age, sex and pre-hypertension (p-value <0.05). Furthermore, there is a statistically significant association (p-value <0.05) between body weight (overweight and obesity) and pre-hypertension as a higher percentage of students that were overweight and obese had pre-hypertension (45.9%) compared to normal and underweight students (35.6%).

Table 6: Bivariate analysis showing the association between socio demographics characteristics of students and Pre-hypertension and Hypertension
Similar findings were observed for hypertension. Over the ten-year period, there was a significant association between age and hypertension ($p$-value<0.05). The percentage of students with hypertension increased with age such that those aged above 41 years had most cases of hypertension (29.0%) unlike those aged 16-20 years (5.0%). Male students were also more hypertensive (11.2%) compared to their female counterparts (4.8%) and this difference is statistically significant ($p$-value<0.05). More postgraduate students (10.4%) had hypertension compared to undergraduate students (6.0%) and this difference was statistically significant ($p$-value<0.05). There is a statistically significant association ($p$-value <0.05) between body weight (overweight and obesity) and hypertension as a higher percentage of students that were overweight and obese were hypertensive (14.2%) compared to normal and underweight students (5.9%).

The odds of prehypertension increased with age; students aged 41 years and above were 3 times more likely to have prehypertension compared to those aged 16-20 years (OR=2.17, CI:1.94-2.43) and male students were more likely to be hypertensive compared to females (OR=2.40, CI:2.34-2.52).

Similarly, the odds of hypertension increased with age such that students aged 41 years and above were 7 times as likely as those aged 16-20 years to have hypertension (OR=6.11, CI: 5.29-7.06). Female students were less likely to be hypertensive (OR=0.38, CI: 0.36-0.42) than their male counterparts. Overweight/obesity was also associated with higher risk of hypertension (OR=2.25, CI: 2.10-2.41) [see Table 7].

Table 7: Multivariate analysis showing the association between socio demographics characteristics of students and Prehypertension and Hypertension
Discussion

This study describes the burden of overweight and obesity and associated risk factors for chronic, non-communicable diseases among newly admitted students of the University of Ibadan. The study participants consisted of adolescents and young adults who came in as freshmen for undergraduate studies and those who had returned or enrolled for postgraduate studies in the University of Ibadan.

Burden of overweight and obesity

The prevalence for overweight and obesity in this study were 18.7 and 7.2% respectively. Similar studies carried out majorly among undergraduates to determine the prevalence of overweight and obesity in Nigerian universities recorded prevalence rates of 16.2% and 4.8% [34] and 25% and 11% [35] respectively. This finding aligns with the overall prevalence for overweight and obesity in a multi-centre study among low-middle income countries including Nigeria which were 22% and 5.8% [12] and in Ghana, 25.8% and 5.9% respectively [36] In this study, overweight and obesity had significant relationships with the older age group, being female and undergoing postgraduate training.

We found a consistently increasing trend of overweight and obesity with age. This trend persists till later years of postgraduate programme depicting increasing risk of obesity at middle age and later in adulthood. This aligns with the findings from the global study of overweight and obesity in children and adults which showed that in both developed and developing countries, successive cohort from 1980 to 2013 tend to gain weight at all ages and the most rapid weight gains occurred between the ages of 20 and 40 years [37]. The persistence in overweight and obesity till later years of study, despite the rigors of academic work in the university, has also been documented in other studies in both LMIC and industrialized countries [7, 12, 38]. This is not surprising given the fact that the students are being exposed to an environment of independence, urban lifestyle with unfettered access to fast food, high sweetened drinks and energy-dense foods without investment in built environment for physical activity. Furthermore, previous study showed that university students lack knowledge about healthy food choices and this has negative influence on their eating habits and nutritional
status [39,40]. Where exposure to obesogenic environment persists, students who were underweight are at risk of transition to overweight and obesity across the life course.

**Double Burden of Malnutrition**

Our findings revealed a double burden of malnutrition characterized by the co-occurrence of undernutrition along with overweight and obesity. In this study, the female gender had a higher burden of abnormal BMI with co-occurrence of underweight, overweight and obesity similar to studies reported in other LMIC [41,42]. Furthermore, there was an increasing shift from undernutrition to overnutrition at each year of entry of the study participants to the University. The double burden of malnutrition documented in this study is similar to findings reported among students of tertiary institutions in different geopolitical regions of Nigeria [35, 43] and other low- and middle-income countries [12]. According to the World Health Organization (WHO), a double burden of malnutrition can be found at individual level comprising abnormal weight with deficiency of one or various vitamins and minerals; at the household level and at the population level – where there is a prevalence of both undernutrition and overweight in the same community, nation or region [5, 44]. Studies emanating from LMIC have documented the coexistence of underweight and overweight within the same family [45,46] and communities [47, 47-49]. The occurrence of double burden of malnutrition as found in this study reflects the picture of the general Nigerian population [50] and many developing countries that are experiencing nutrition and socioeconomic transitions [51,52]. This strongly implies that environmental, nutrition and socio-economic variables rather than genetic factors are likely responsible for the ongoing dramatic double burden of malnutrition in LMIC.

The double burden of malnutrition is a complex and important phenomenon because of the relationship and biological link between the diverse forms of malnutrition beyond coexistence. For example, a stunted child is more likely to be overweight and/or affected by NCDs as an adult [53]. At the same time, undernutrition in form of nutritional deficiencies is an important underlying risk factor for major communicable diseases and global child mortality [54,55]. Thus, the double burden of malnutrition at a younger age is a silent driver of the double burden of infectious and non-communicable diseases [54] later in life. The phenomenon of dual burden of malnutrition also presents a major public health challenge for the health care system [56].

Our findings underscore three important points. First is that the burgeoning prevalence and pattern of overweight and obesity across the age groups, from different locations suggest a strong environmental/social causative factor deserving further attention as possible target for intervention. Second, the evidence indicates the need to implement lifestyle-related interventions as part of efforts to halt the progression of obesity and prevent the emergence of chronic disease risks later. Third, greater success may be achieved in curbing overnutrition if the prevailing environmental and social factors are explored further for appropriate intervention. While diseases associated with undernutrition remain a major concern at the face of economic and social transitions, LMIC are experiencing a marked increase in overweight and obesity. This implies that overweight and obesity epidemic is unrelenting and may soon dominate the risk profile for chronic diseases if unaddressed. According to WHO, this double burden of malnutrition offers a unique and important opportunity for integrated action on malnutrition in all its forms. There is an urgent need for double-duty actions “which are interventions, programs, and policies that have the potential to simultaneously reduce the risk and burden of under and overnutrition” [5, 54] targeted at the University community and country at large.

**Obesity-related health conditions**

Hypertension was the most prevalent chronic condition among the study participants and its prevalence was 8.1% which is consistent with the prevalence of a study conducted among Ethiopian students where the prevalence was noted to be 7.4% [57]. Studies indicate that 90% of young people with hypertension have primary or essential hypertension which has no specific cause but well-defined risk factors [58,59,60]. In this study, hypertension had significant relationships with older age group, being a male, undergoing postgraduate studies, overweight or obese and those with a family history of
Hypertension. As overweight and obesity rates increased among the study population, there was a parallel rise in the prevalence of hypertension across the age-groups. Similar finding has been documented among students of a tertiary institution in Cameroon [38].

Hypertension is the leading cause of death globally and most important risk factor for cardiovascular disease, stroke, and chronic kidney disease (CKD) [33, 61]. Available evidence shows that young people with hypertension have similar target-organ damage such as left ventricular hypertrophy (LVH), microalbuminuria and carotid intimal thickness as older adults with hypertension [62]. LVH is one of the early manifestations and immediate consequences of hypertension. The results of this study showed that only a small proportion of the study participants had Electrocardiography (ECG) done as part of the evaluation for hypertension-related target organ damage. The ECG of about three-quarters of those evaluated revealed LVH. This has to be interpreted with caution because ECG is not validated for diagnosis of LVH in young individuals [63]. A previous study showed that left ventricular hypertrophy is present in about 20–40 % of children and adolescents with high BP, and represents a compelling indication for starting an antihypertensive drug treatment [64]. LVH and other target organ markers are associated with adverse cardiovascular outcomes and risks for end stage renal disease, retinopathy, ruptured aortic aneurysm, stroke and impaired cognitive function [58, 60]. These complications and their consequences are unlikely to be clinically apparent for many years in adolescence and young adulthood. Thus, there is a need to adapt and follow recommended guidelines for the investigation and management of hypertension and co-morbidities in young people.

Also, our study revealed that a third of the study population (35.1%) had prehypertension. Reports from many studies indicate that prehypertension is common among adolescents and young adults with evidence of target organ damage already present. Prehypertension is not considered a disease category, but identifies those who are likely to progress to stage 1 or stage 2 hypertension in the future [65,66] without intervention. It is a strong predictor of hypertension and future cardiovascular disease [67,68]. The significant relationship between prehypertension and being overweight and obese in this study implies that the burden of hypertension and cardiovascular disease may increase if the obesity epidemic continues to spiral out of control.

**Implications for Interventions**

Primary prevention remains the most realistic strategy to curb the growing burden of obesity and obesity-related health conditions among adolescents and young people. This is pertinent considering that overweight/obesity and related health conditions documented among adolescents and young adults in this study predates their entry to the university. Unfortunately, the systematic reviews of studies have reported gaps in the number and quality of obesity prevention interventions conducted within the adolescents and young adult age groups in developing countries [69, 70]. Young people represent a unique age group whose views and health needs are not being adequately addressed by the health management information system. For instance, there was apparent neglect of adolescents (with the exception of married female adolescents) during the collection of national data on nutrition during the Nigeria Demographic Health Surveys [50]. In addition, policies and programmes to address nutrition in Nigeria remain skewed towards undernutrition and children under five years [50, 71]. To tackle obesity among Nigerian adolescents and young people, a critical step is the collection of data on its burden, risk factors and trends. Furthermore, there is a need for holistic, synergistic mix of population-level interventions such as the provision of physical activity facilities, coupled with the regulation of labelling, marketing, content and pricing of energy-dense foods and sugar-sweetened beverages which target the obesogenic environment and requires a multi-sectoral approach [71, 72].

The strengths of this study include the large population of adolescent and young people from diverse geographical and social background as participants. Population-based studies on obesity and emerging NCD risks are needed to build an evidence base that socially and culturally reflects the reality in developing countries. This is a novel study that included both undergraduate and postgraduate students covering broad spectrum of adolescents, young and middle-aged adults.
Hitherto, studies on obesity and overweight problems were mainly carried out on undergraduate students. The study spans over a ten-year period which shows trends in obesity and hypertension, thus increasing the validity and power of this study. The findings from this study will add to the body of knowledge on the burden of obesity and overweight among university students both in Nigeria and globally which will assist in planning effective health intervention programmes to reduce the heavy burden of obesity noted among university students.

Key limitations include lack of data on dietary intake, physical activity, socio-economic status, smoking and alcohol consumption and other emerging lifestyle risk factors on obesity and overweight which could provide a richer perspective on the factors contributing to the burden of obesity and associated diseases among this population. In addition, another limitation is the use of ECG and not Echocardiography which is the validated test for the diagnosis of LVH in young individuals thereby limiting the usefulness of LVH finding in this study.

Conclusion

This study has identified the burden of double malnutrition, rising trends in the prevalence of obesity among students in a tertiary institution and the emergence of chronic disease risks with a lifelong implication on their health and a concomitant burden on the health system. Evidence-based, cost effective interventions are urgently needed at the secondary and tertiary-level educational institutions to address the growing burden of obesity among this population. These interventions must be holistic and transcend obesity awareness programmes to include those which target the obesogenic physical and policy environments and empower young people to adopt appropriate healthy behaviours.

Abbreviations

BMI – Body mass index
BP – Blood pressure
CI – Confidence Interval
CKD – Chronic kidney disease
CVD – Cardiovascular disease
ECG - Electrocardiography
JNC7 – Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure
LMIC – Low-and-middle income countries
LVH – Left ventricular hypertrophy
NCDs – Non-communicable diseases
SD – Standard deviation
UI/SSHREC – Social Sciences and Humanities Research Ethics Committee (SSHREC), University of Ibadan
UHS – University Health Services
UI – University of Ibadan
Declarations

*Ethics approval and consent to participate*

This study was approved by the Social Sciences and Humanities Research Ethics Committee (SSHREC), University of Ibadan and the assigned reference number is [UI/SSHEC/2020/0021].

*Consent for publication*

Not applicable

*Availability of data and materials*

The datasets are available upon request to the corresponding author. This can only be used for non-commercial purposes while maintaining participants’ confidentiality.

*Competing interests*

The authors declare that they have no competing interests.

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*Authors’ contributions*

The study was conceived by AOO. MMO, JOA, AJA, ASJ, GD and OOA contributed to the design of the study. The data collection was carried out by OLO, AOO, MMO and JB. JOA, AOO and MMO analyzed the data, AOO, MMO, JOA and OBO wrote the manuscript, AJA, GD and ASJ revised and provided critical review of the manuscript. All authors read and approved the final manuscript.

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*References*

1. Eckel RH, York DA, Rössner S, Hubbard V, Caterson I, St. Jeor ST, Hayman LL, Mullis RM, Blair SN. Prevention Conference VII: Obesity, a worldwide epidemic related to heart disease and stroke: executive summary. Circulation. 2004 Nov 2;110(18):2968-75.
2. World Health Organization. Obesity and Overweight. 2020. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed 22/05/2020
3. Chhatwal J, Verma M, Riar SK. Obesity among pre-adolescent and adolescents of a developing country (India). Asia Pacific journal of clinical nutrition. 2004 Sep 1;13(3).
4. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. International journal of pediatric obesity. 2006 Jan 1;1(1):11–25.
5. WHO. The double burden of malnutrition: policy brief. Geneva; 2017, p. 10. Report No.: WHO/NMH/NHD/17.3. Available from: <http://www.who.int/nutrition/publications/doubleburdenmalnutrition-policybrief/en/>

6. Mirmiran P, Mirbolooki M, Azizi F. Familial clustering of obesity and the role of nutrition: Tehran Lipid and Glucose Study. International journal of obesity. 2002 Dec;26(12):1617–22.

7. Vadeboncoeur C, Foster C, Townsend N. Freshman 15 in England: a longitudinal evaluation of first year university student’s weight change. BMC obesity. 2016 Dec 1;3(1):45.

8. Sa J, Cho BY, Chapat JP, Chung J, Choe S, Gazmarrison JA, Shin JC, Lee CG, Navarrette G, Han T. Sex and racial/ethnic differences in the prevalence of overweight and obesity among US college students, 2011–2015. Journal of American College Health. 2019 Oct 31:1–9.

9. Nwachukwu DC, Nwagha U, Obikili EN, Ejezie FE, Okwuosa CN, Nweke ML, Ezeh CO. Assessment of body mass index and blood pressure among university students in, Enugu, South East, Nigeria. Nigerian Journal of Medicine. 2010;19(2).

10. Ejike CE, Ijeh II. Obesity in young-adult Nigerians: variations in prevalence determined by anthropometry and bioelectrical impedance analysis, and the development of% body fat prediction equations. International Archives of Medicine. 2012 Dec 1;5(1):22.

11. Cilliers J, Senekal M, Kunneke E. The association between the body mass index of first-year female university students and their weight-related perceptions and practices, psychological health, physical activity and other physical health indicators. Public Health Nutrition. 2006 Apr;9(2):234–43.

12. Pengpid S, Peltzer K. Prevalence of overweight/obesity and central obesity and its associated factors among a sample of university students in India. Obesity research & clinical practice. 2014 Nov 1;8(6):e558-70.

13. Gopalakrishnan S, Ganeshkumar P, Prakash MV, Amalraj V. Prevalence of overweight/obesity among medical students, Malaysia. The Medical Journal of Malaysia. 2012 Aug 1;67(4):442-4.

14. Boo NY, Chia GJ, Wong LC, Chew RM, Chong W, Loo RC. The prevalence of obesity among clinical students in a Malaysian medical school. Singapore medical journal. 2010 Feb 1;51(2):126.

15. Haddad LJ, Hawkes C, Achadi E, Ahuja A, Ag Bendech M, Bhatia K, Bhutta Z, Blossner M, Borghi E, Eriksen K, Fanzo J. Global Nutrition Report 2015: Actions and accountability to advance nutrition and sustainable development. Intl Food Policy Res Inst; 2015 Sep 15.

16. NCD Risk Factor Collaboration. Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants. The Lancet. 2016 Apr 2;387(10026):1377-96.

17. Gordon-Larsen P, The NS, Adair LS. Longitudinal trends in obesity in the United States from adolescence to the third decade of life. Obesity. 2010 Sep;18(9):1801–4.
22. Butler SM, Black DR, Blue CL, Gretebeck RJ. Change in diet, physical activity, and body weight in female college freshman. American journal of health behavior. 2004 Jan;28(1):24–32.

23. Ramalho AA, Dalamaría T, Souza OF. Regular consumption of fruits and vegetables by university students in Rio Branco, Acre State, Brazil: prevalence and associated factors. Cadernos de Saúde Pública. 2012 Jul;28(7):1405–13.

24. El Ghaizali S, Ibrahim JM, Kandari BM, Ismail NA. The relationship between lifestyle and body mass index among university students in Kuwait, Egypt. J. Community Med. 2010;28(1):69–76.

25. Aucott L. Mental Well-Being Related To Lifestyle and Risky Behaviours in 18–25 Year Old: Evidence from North-East Scotland. International Journal of Public Health Research. 2014 Mar 1;4(1):431 – 40.

26. El-Kassas G, Itani L, El Ali Z. Obesity risk factors among Beirut Arab University students in Tripoli-Lebanon. Journal of Nutrition & Food Sciences. 2015 Jan 1;5(6):1.

27. Sparling PD. Obesity on campus. Preventing chronic disease: Public health research, practice and policy.

28. Skinner AC, Mayer ML, Flower K, Weinberger M. Health status and health care expenditures in a nationally representative sample: how do overweight and healthy-weight children compare? Pediatrics 2008;121:e269-e277

29. Kernan WN, Dearborn JL. Obesity increases stroke risk in young adults: opportunity for prevention. Stroke. 2015;46:1435–6.

30. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. International journal of obesity. 2011 Jul;35(7):891–8.

31. Poobalan A, Aucott L. Obesity among young adults in developing countries: a systematic overview. Current obesity reports. 2016 Mar 1;5(1):2–13.

32. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, Jones DW, Kurtz T, Sheps SG, Roccella EJ. Recommendations for blood pressure measurement in humans and experimental animals: part 1: blood pressure measurement in humans: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Hypertension. 2005 Jan 1;45(1):142 – 61.

33. Chobanian AV. National heart, lung, and blood institute joint national committee on prevention, detection, evaluation, and treatment of high blood pressure; national high blood pressure education program coordinating committee: the seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. Jama. 2003;289:2560–72.

34. Gwarzo IM, Adam MN, Wali NY, Ibrahim SA. Correlation of anthropometric indices with fasting blood glucose and blood pressure among university students in Kano, Nigeria. Nigerian Journal of Basic and Clinical Sciences. 2020 Jul 1;17(2):128.

35. Agwu EM, Draper S, Croix MD, Egimot-Nwadiaro R, Onuoha CR. Health rating, obesity and hypertension among university students in nigeria by gender and ethnicity. Public Health Int. 2017 Sep 28;2:131–43.

36. Mogre V, Nyaba R, Aleyira S. Lifestyle risk factors of general and abdominal obesity in students of the school of medicine and health science of the University of Development Studies, Tamale, Ghana. International Scholarly Research Notices. 2014;2014.

37. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, Mullany EC, Biryukov S, Abbafati C, Abera SF, Abraham JP. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. The lancet. 2014 Aug 30;384(9945):766 – 81.

38. Choukem SP, Kengne AP, Nguefack ML, Mboue-Djieka Y, Nebongo D, Guimezap JT, Mbanya JC. Four-year trends in adiposity and its association with hypertension in serial groups of young adult university students in urban Cameroon: a time-series study. BMC Public Health. 2017 Dec;17(1):1–6.
39. Ukegbu PO, Uwaegbute AC, Echendu CA, Ejike C, Anyika-Elekeh JU, Asumugha VU, Kuyik SA, Omodamiro S, Nwofia B, Uzokwe C, Oluchi-Nliam C. Obesity and associated factors in young adults attending tertiary institutions in south-eastern Nigeria. South African journal of clinical Nutrition. 2017;30(2).

40. Gan WY, Mohd Nasir MT, Zalilah MS, et al. Differences in eating behaviors, dietary intake and body weight status between male and female Malaysian university students. Mal J Nutr. 2011;17(2):213–28.

41. Zeba AN, Delisle HF, Renier G, Savadogo B, Baya B. The double burden of malnutrition and cardiometabolic risk widens the gender and socio-economic health gap: a study among adults in Burkina Faso (West Africa). Public health nutrition. 2012 Dec;15(12):2210–9.

42. Hanandita W, Tampubolon G. The double burden of malnutrition in Indonesia: Social determinants and geographical variations. SSM-population health. 2015 Dec 1;1:16–25.

43. Oluwaseyi JO, Omotayo OA. Prevalence of obesity among undergraduate students of tai Solarin University of Education, Ijagun, Ijebu-ode. Pak J Nutr. 2011;10(10).

44. Griffiths PL, Bentley ME. The nutrition transition is underway in India. J Nutr. 2001;131:2692–2700.

45. Florêncio TM, da Silva Ferreira H, de França AP, Cavalcante JC, Sawaya AL. Obesity and undernutrition in a very-low-income population in the city of Maceio, northeastern Brazil. British Journal of Nutrition. 2001 Aug;86(2):277–83.

46. Garrett J, Ruel MT. The coexistence of child undernutrition and maternal overweight: prevalence, hypotheses, and programme and policy implications. Maternal & child nutrition. 2005 Jul;1(3):185–96.

47. Shafique S, Akhter N, Stalakkamp G, de Pee S, Panagides D, Bloem MW. Trends of under- and overweight among rural and urban poor women indicate the double burden of malnutrition in Bangladesh. International journal of epidemiology. 2007 Apr 1;36(2):449 – 57.

48. Kimani-Murage EW, Muthuri SK, Oti SO, Mutua MK, van de Vijver S, Kobutungi C. Evidence of a double burden of malnutrition in urban poor settings in Nairobi, Kenya. PloS one. 2015 Jun 22;10(6):e0129943.

49. Maehara M, Rah JH, Roshita A, Suryantan J, Rachmadewi A, Izwardy D. Patterns and risk factors of double burden of malnutrition among adolescent girls and boys in Indonesia. PloS one. 2019 Aug 20;14(8):e0221273.

50. National Population Commission/Nigeria and ICF, 2019. Nigeria Demographic and Health Survey 2018 Key Indicators Report. Abuja, Nigeria, and Rockville, Maryland, USA Retrieved on 15th October, 2020 from https://www.dhsprogram.com/pubs/pdf/FR359/FR359.pdf

51. Doak CM, Adair LS, Bentley M, Monteiro C, Popkin BM. The dual burden household and the nutrition transition paradox. Int J Obes. 2005;29:129–136.

52. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutrition reviews. 2012 Jan 1;70(1):3–21.

53. Hawkes C, Demaio AR, Branca F. Double-duty actions for ending malnutrition within a decade. The Lancet Global Health. 2017 Aug 1;5(8):e745-6.

54. Kolčič I. Double burden of malnutrition: A silent driver of double burden of disease in low- and middle- income countries. Journal of global health. 2012 Dec;2(2).

55. Black RE, Allen LH, Bhutta Z, Caulfield LE, de Onis M, Ezzati M, et al. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet. 2008;371:243–60. doi: 10.1016/S0140-6736(07)61690-0.

56. Popkin BM, Corvalan C, Grummer-Strawn LM. Dynamics of the double burden of malnutrition and the changing nutrition reality. The Lancet. 2020 Jan 4;395(10217):65–74.

57. Tadesse and Alemu: Hypertension and associated factors among university students in Gondar, Ethiopia: a cross sectional study, BMC Public Health, 2014, 14:937.

58. Drukteinis J, Roman M, Fabsitz R, et al. Cardiac and systemic hemodynamic characteristics of hypertension and prehypertension in adolescents and young adults: The Strong Heart Study. Circulation 2006;115(2):221–227.
59. Flynn JT. Hypertension in children. In: Kaplan N, ed. Kaplan's Clinical Hypertension. 9th ed. Philadelphia: Lippincott Williams and Wilkins, 2006.

60. Assadi F. The growing epidemic of hypertension among children and adolescents: A challenging road ahead. Pediatr Cardiol 2012;33(7):1013–1020.

61. National High Blood Pressure Education Program Working Group on High Blood Pressure in C, Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics. 2004;114

62. Tirosh A, Afek A, Rudich A, Percik R, Gordon B, Ayalon N, Derazne E, Tzur D, Gershanel D, Grossman E, Karasik A. Progression of normotensive adolescents to hypertensive adults: a study of 26 980 teenagers. Hypertension. 2010 Aug 1;56(2):203-9.

63. Hancock E, Deal B, Mirvis D, Okin P, Kligfield P, Gettes L. AHA/ACCF/HRS Recommendations for the Standardization and Interpretation of the Electrocardiogram: Part V: Electrocardiogram Changes Associated With Cardiac Chamber Hypertrophy. Circulation 2009;119(10):e251-e261

64. Brady TM, Fivush B, Flynn JT, Parekh R. Ability of blood pressure to predict left ventricular hypertrophy in children with primary hypertension. J Pediatr. 2008;152(1):73–8(8 e1)

65. Saseen J. Essential hypertension. In: Alldredge BK, Corelli RL, Ernst ME, Guglielmo BJ, Jacobson PA, Kradjan WA, Williams BR, editors. Koda-Kimble and Young's Applied Therapeutics: The Clinical Use of Drugs. 10th ed. Philadelphia: Lippincott Williams & Wilkins; c2013. Chapter 14.

66. Saseen JJ, MacLaughlin. Hypertension. In: DiPiro JT, Talbert RL, Yee GC, Matzke GR, Wells BG, Posey LM, editors. Pharmacotherapy: A pathophysiologic approach. 9th ed. New York: McGraw-Hill Medical; c2014. Chapter 3.

67. Mahadir Naidu B, Mohd Yusoff MF, Abdullah S, Musa KI, Yaacob NM, Mohamad MS, Sahril N, Aris T. Factors associated with the severity of hypertension among Malaysian adults. PLoS One. 2019;14(1):e0207472.

68. Lyu Qing-shan, Huang Yin-quing. The Relationship between Serum Total Bilirubin and Carotid Intima-Media Thickness in Patients with Pre-hypertension. Annals of Clinical Laboratory Science, 2018, 48(6):757–763.

69. Klingberg S, Draper CE, Mckrokesfield LK, Benjamin-Neelon SE, van Sluijs EM. Childhood obesity prevention in Africa: A systematic review of intervention effectiveness and implementation. International journal of environmental research and public health. 2019 Jan;16(7):1212.

70. Salam RA, Padhani ZA, Das JK, Shaikh AY, Hoodbhoy Z, Jeelani SM, Lassi ZS, Bhutta ZA. Effects of lifestyle modification interventions to prevent and manage child and adolescent obesity: a systematic review and meta-analysis. Nutrients. 2020 Aug;12(8):2208.

71. Oluwasanu M, Oladunni O, Oladepo O. Multisectoral approach and WHO ‘Bestbuys’ in Nigeria’s nutrition and physical activity policies. Health Promotion International. 2020 Feb 22, 1–11

72. Baker P, Gill T, Friel S, Carey G, Kay A. Generating political priority for regulatory interventions targeting obesity prevention: an Australian case study. Social science & medicine. 2017 Mar 1;177:141–9.

Figures
Figure 1
Trends in prevalence of underweight, 2009-2018

Figure 2
Trend of Overweight & Obesity among university of Ibadan students (2009-2018)
Figure 3

BMI categories according to sex of students in University of Ibadan

Figure 4

Trend of Hypertension cases among university of Ibadan students (2009-2018)