HYDRATION STATUS AND CONTRIBUTION OF WATER AND BEVERAGES TO TOTALFLUID INTAKE OF UNDERGRADUATE STUDENTS (16-24 YEARS) IN NIGERIAN UNIVERSITIES

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TITLE PAGE

HYDRATION STATUS AND CONTRIBUTION OF WATER AND BEVERAGES TO FLUID INTAKE OF UNDERGRADUATE STUDENTS (16-24 YEARS) IN NIGERIAN UNIVERSITIES

A THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE IN HUMAN NUTRITION

BY

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CERTIFICATION

ONODUGO NKECHINYEREM GIFT, a postgraduate student of the Department of Nutrition and Dietetics with Registration Number PG/Ph.D/16/81419 has satisfactorily completed the research work for the award of Degree of Ph.D in Human Nutrition. The work embodied in the project is original as has not been submitted in part or full for any other diploma or degree of this or any other university.

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DEDICATION

This work is dedicated to Almighty God who made it possible in ramification to bring this programme to a reasonable conclusion and most especially for saving me from road traffic accident that would have claimed my precious life just at the verge of the completion of the thesis. May His adorable name be praised, Amen.

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Onodugo Nkechinyerem Gift
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TABLE OF CONTENTS

Title Page	i
Certification	ii
Approval Page	iii
Dedication	iv
Acknowledgements	v
Table of Contents	vii-x
List of Tables	xi
List of Figures	xii-xiii
Abstract	xiv

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study	1
1.2 Statement of the Problem	5
1.3 Objectives of the Study	8
1.4 Significance of the Study	9

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of undergraduate student's lifestyle	10
2.2 Overview of fluid, water and beverage	12
2.3 Factors affecting fluid intake and hydration status of humans	22
2.4 Hydration status and categorization	26
2.5 Prevalence of hypo and euhydration among university students	29
2.6 Hydration status, human health and cognition	29
2.7 Methods of assessing fluid intake status in man	31
2.8 Methods of assessing hydration status in human	32

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area 44

3.2 Study design 45

3.3 Study population 45

3.4 Sample size determination 45

3.5Sampling technique 52

3.6 Sub sample 52

3.7 Inclusion and exclusion criteria 53

3.8 Recruitment and training of research assistants 53

3.9 Ethical approval 53

3.10 Informed consent 53

3.11 Method of data collection 54

3.12Questionnaire 54

3.13Assessment of fluid intake with a seven-day fluid specific record 54

3.14Urine specific gravity (USG) 56

3.15Urine sample collection 56

3.16Urine colour test 56

3.17Statistical analysis 58

CHAPTER FOUR: RESULTS

4.1a: Sex, age and place of residence of the respondents 59

4.1b: Marital status, educational level and monthly allowance of the respondents 61

4.2a: Source of drinking water, frequency and quantity of water taken each time 63

4.2b: Pattern of water consumption of the respondents 65

4.3: Beverage consumption of the respondents by institutions 67

4.4: Daily total fluid intake and contribution of water and beverage to the overall fluid intake 94

4.5: Daily total fluid intake and contribution of water and beverage to the overall fluid intake of respondents by gender 95

4.6: Correlation between fluid, water and beverage intake of respondents 96

4.7: Correlation between fluid intake, urine specific gravity and urine colour of respondents 98

4.8: Hydration status of the respondents from the measurements of refractometer based on institution 99

4.9: Hydration status of the respondents from the measurements of refractometer based on gender 100

4.10: Hydration status of the respondents based on urine colour by institutions 101

4.11: Hydration status of the respondents based on gender 102

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Background and demographic characteristics of respondents 103

5.2 Source of water, frequency and quantity of water consumption each time 104

5.3 Pattern of water consumption of the respondents 107

5.4 Beverage consumption of the respondents by institutions 108

5.5 Frequency of beverage intake of the respondents 109

5.6 Time of beverages were consumed alone and with meals by the respondents 110

5.7 Pattern of beverage intake of respondents by institutions 111

5.8 Factors that influenced water intake of respondents 111

5.9 Factors that affected beverage consumption of respondents 112

5.10 Daily fluid intake, contribution of water and beverage on total fluid intake of respondents 112

5.11 Fluid intake and contribution of water and beverage to the overall fluid intake of respondents by gender 113

5.12 Correlation between fluid, water and beverage consumption of respondents 113

5.13 Correlation between fluid intake, urine specific gravity and urine colour of respondents 113

5.14 Hydration status of respondents by institutions using both refractometer measurements and urine colour chart matching 114

5.15 Hydration status of respondents by institutions using refractometer measurements and urine colour based on gender 114

5.16 Conclusion 115

Recommendation 116

References 118

Appendix

Consent Form

Ethical clearance

Questionnaire

LIST OF TABLES

Table 1: Recommendations for total water intake for different age-groups (L/day) 15

Table 3.1: Number of required faculties and department 46

Table 3.2: Number of faculties and respondents 48

Table 3.3: Number of departments selected from each faculty 49

Table 4.1a: Sex, age, place of residence, and marital status of the respondents 60

Table 4.1b: Marital status, educational level and monthly allowance of the respondents 62

Table 4.2a: Source of drinking water, frequency and quantity of water taken each time 64

Table 4.2b: Pattern of water consumption of the respondents 66

Table 4.3: Beverage consumption of the respondents by institutions 67

Table 4.4: Daily total fluid intake and contribution of water and beverage to the overall fluid intake 94

Table 4.5: Daily total fluid intake and contribution of water and beverage to the overall fluid intake of respondents by gender 95

Table 4.6: Correlation between fluid, water and beverage intake of respondents 97

Table 4.7: Correlation between fluid intake, urine specific gravity and urine colour of respondents 98

Table 4.8: Hydration status of the respondents from the measurements of refractometer based on institution 99

Table 4.9: Hydration status of the respondents from the measurements of refractometer based on gender 100

Table 4.10: Hydration status of the respondents based on urine colour by institutions 101

Table 4.11: Hydration status of the respondents based on gender 102

LIST OF FIGURES

Figure 1: Popular beverages consumed in Nigeria 21

Figure 2: Armstrong's Colour chart 58

Figure 4.1: Frequency of cow and soybean milk consumption of respondents by institution 68

Figure 4.2: Frequency of consumption of hot beverages and 100% fruit juice of respondents by institution 69

Figure 4.3: Frequency of soft and fruit drink of respondents by institution 70

Figure 4.4: Frequency of energy and malt drink consumption of respondents by institution 71

Figure 4.5: Frequency of consumption of flavoured water and alcoholic beverages of respondents by institution 72

Figure 4.6: Frequency of zobo and kunu drink consumption of respondents 73

Figure 4.7: Time beverages were consumed alone by respondents 74

Figure 4.8: Time beverages were consumed with meals by respondents 75

Figure 4.9: Pattern of cow milk/hot beverage consumption of respondents by institution 76

Figure 4.10: Pattern of 100% fruit juice and soft drink consumption of respondents by institution 77

Figure 4.11: Pattern of fruit/energy drink consumption of respondents by institution 78

Figure 4.12: Pattern of consumption of malt and flavoured water of the respondents by institution 79

Figure 4.13: Pattern of alcoholic, zobo and kunu drink consumption of respondents by institution 80

Figure 4.14:Influence of cost and diet/nutrition on water consumption of respondents 81

Figure 4.15: Influence of availability and perceived health benefit on the consumption of respondents 82

Figure 4.16: Influence of exercise and thirst on consumption of water of the respondents 83

Figure 4.17: Influence of environment and illness on water consumption of respondents 84

Figure 4.18: Influence of medication on water consumption of respondents 85

Figure 4.19: Influence of clothing and hunger on consumption of water of respondents 86

Figure 4.20: Influence of cost of beverage, ability to produce beverage and nutrition label information on water consumption of respondents 87

Figure 4.21: Influence of peer group, having parents who drink and emotion on consumption of beverage of respondents 88

Figure 4.22: Influence of having no time to prepare meals, studying and travelling on the consumption of beverage of respondents 89

Figure 4.23: Influence of taste, availability of beverage and partying on beverage consumption of respondents 90

Figure 4.24: Influence of perceived health benefit, quality and advertisement on beverage consumption of respondents 91

Figure 4.25: Influence of feeling to drink, drinking to induce sleep and to increase energy on consumption of beverage of the respondents 92

Figure 4.26: Influence of drinking to reduce anxiety and worries and for prestige on the consumption of beverages of the respondents 93

ABSTRACT

This work assessed the hydration status and contribution of water and beverages to fluid intake of undergraduate students (16-24 years) in Nigeria Universities. The study adopted a cross sectional survey design among the students from three federal universities in Nigeria located at different regions. Multiple stage sampling technique was used to select a sample size of 3248 (1824 males and 1424 females) from the three universities namely: Ahmade Bello University Zaria (ABU), University of Ibadan (UI) and University of Nigeria, Nsuuka (UNN). A sub-sample of 162 respondents (5% of the sample) was randomly selected for hydration status and fluid intake studies. A structured questionnaire was used to obtain information on socio demographic characteristics, frequencies and pattern of water and beverage consumption. The likert scale attitude continuum was used to determine factors that influenced water and beverage intakes. A 7-day fluid specific record was employed for the assessment of fluid intake. The portable hand-held urine refractometer (ERMA Hand Refractometer) and urine colour chart were used for the assessment of hydration status of respondents. The structured questionnaire was subjected to Cronbach alpha reliability test with coefficient of 0.82. Data obtained were coded into excel and cleaned to ensure that accurate information was obtained and was transferred to the Statistical Product and Service Solution (IBM-SPSS) version 20 for data analysis. Chi-square and Pearson correlation were used to explore the relationship among variables and results were presented as frequencies and percentages. Significance was accepted at $p< 0.05$. The result showed that more than half (56.2%) of respondents were males, and 65.9% were between the ages of 20-24 years old. A good number (57.1%) of respondents lived in the hostel while 42.9% lived off-campus at the time of the study. Majority (95.1%) of respondents were single. About 28% were 100 level students in terms of educational level with over 70% having monthly allowance of less than ₦25, 000. Tap and bottle water were the major (34.2% and 33.6%) source of drinking water, respectively. More than half (55.4%) of respondents drank water 3-6 times a day. In terms of pattern of drinking of water, 75.1% of respondents drank water anytime of the day, 58.7% drank water on awakening, and 81.7% took water while eating meals. Nearly all (97.2%) of respondents consumed water when they are thirsty. Approximately 96% of respondents attest to consuming beverages and only 4.3% did not. Frequency of beverage intake of respondents showed that ABU and UNN students rarely consumed cow milk and its products (37.6% and 42.3%), soy bean milk 0(57.8% and 55.2%), 100% fruit juice (41.0 and 43.2%), and fruit drink (45.1% and 44.0%), respectively compared to those in UI. Mean contribution of water (2.39 L for ABU, 2.17 L for UI and 2.15 L for UNN) was not significantly different $p< 0.05$ from that contributed by beverages (0.43 L for ABU, 0.49 L for UI and 0.48 L for UNN). Hydration status of respondents using refractometer measurement showed that more than two-third (85.8%) of them were normally hydrated and little above seventy percent (74.1%) were euhydrated judging from the urine coloured chart measurements. Therefore, university undergraduates in Nigeria had normal hydration status even though they did not meet the requirement for fluid intake for their sex and age. Water contributed little more than beverages and almost all the students drank beverages. This reflects the need for nutrition education to sensitize them on the importance of drinking more water to prevent certain non-communicable diseases, enhance their academic performance and avoid the danger of the respondents replacing beverage for water in the future.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Over the years, studies have consistently investigated and provided data on the body composition of nutrients other than water, despite the crucial role it plays in human body. The importance of fluid (water and beverages) to humans cannot be overemphasized. It is difficult to sustain life without it because it can neither be stored nor entirely be conserved in the body. Water is required not only for body functions such as cellular homeostasis, thermoregulation but also for all other biological processes that support life (Platania, Castiglione, Sinatra, D' Urso & Marranzano, 2018). The amount of body water varies according to age such that infants have 75% of their body weight as water; young adults have 60% water in their body while the elderly have 55% of their body weight as water (Platania et al., 2018).

In addition, gender also influence the level of water contained in the body. Fisher (2019) showed that the average adult males within the age of 12 to 18 years have a range of 52%-66%, those 19 to 50 years were between 43% to 73% and those above 51 years have a range of 47% to 67%; females aged 12 to 18 years have 49% to 63%, those within 19 to 50 years have a range of 41% to 60% and others above 51 years have 39% to 57%; and infants and children from birth to 6 months have 64 to 84%, those between 6 months to one year have 57% to 64% while those 1 to 12 years have 49% to 75%. The level of water in the body decreases as the individual ages because of accumulation of more body fat and less fat-free mass.

The volume of total body water (TBW) is subdivided into several sections comprising of extracellular fluid (ECF), plasma volume (PV), and interstitial fluid (IF), intracellular fluid (ICF), red cell volume (RCV) and blood volume (BV). The lymph, saliva and fluid secreted by some

glands, digestive tract, kidneys and skin are classified as extracellular fluid and they occur within the spaces that exist between cells. Abraham and Mohiuddin (2019) demonstrated that intracellular fluid accounts for two-third of the TBW while the remaining one-third is located in the ECW compartment. Similarly, different organs, tissues and other parts of the body contain varying amount of water as follows: the blood plasma contains approximately 90% of the TBW, the brain and the heart have 73%, lungs 83%, skin 64%, muscles and kidneys 79% and bones 31% (Fisher, 2019).

In a 70 kg man with 42 litres of TBW, 28 litres is contained intracellular whereas 14 litres is found extracellular, with 3.1 litres of this extracellular water present in the plasma (Wang, Pierson & Heymsfield, 1992a).Although the fluid volume in the body is sectioned, osmotic, oncotic and hydrostatic forces causes water to constantly move between the different sections with the aid of cell membrane and walls of the blood vessel. Disorders arising from abnormalities in hydration states can manifest in different forms depending on the degree of abnormal distribution between the extra- and intracellular compartments. Plain water and beverages are major sources through which body fluid losses can readily be replaced and by extension determines the hydration state of individuals.

Out of the total fluid recommended to maintain adequate hydration status in the body, 55% need to be supplied by water consumed between 3 to 4 occasions within a day because intake of water that is not up to 3 occasions in a day is considered inadequate and may substantially be associated with dehydration (Senterre, Dramaix & Thiebaut, 2014; Park, Blank, Sherry & O'Toole, 2012). Drinking water can come in form of sparkling or still. Beverages are liquids other than water which are consumed for sustenance, energy and/or hydration. Basically, beverages can be grouped into two classes as alcoholic and non-alcoholic. Alcoholic beverages have varying amount of

ethanol or alcohol while non-alcoholic beverages contain little (0.5%) or no volume of alcohol. Alcoholic beverages are further divided into three categories, which include beers, wines, and spirits. Non-alcoholic beverages may also be classified into two groups as soft and hot drinks. Soft drink are beverages such as carbonated drinks, tonic water, fruit punch, and sparkling water, among others while hot drinks constitutes of beverages like coffee, tea and chocolate.

Hydration status is the level of fluid in the body at a given time and it can be classified into three groups, namely: euhydration, hypohydration and hyperhydration. Euhydration occurs when individuals maintain a proper hydration status, hypohydration refers to decreased level of fluid in the body due to fluid losses exceeding fluid intake, and hyperhydration represents an increase in the fluid contents of the body when fluid intake is in excess of the body's requirements (Cheuvront & Kenefick, 2014). The states of hypohydration and hyperhydration should not be encouraged as they are associated with potential health problems with notable symptoms of dehydration and overhydration, respectively. Powers (2015) grouped these symptoms into three categories to be mild (fluid loss between 3%-5%), moderate (volume loss of 6%-9%) and severe (fluid loss of greater than or equal to 10%).

Mild to moderate symptoms of dehydration are characterized by reduced cognitive and motor functions, headache, difficulty in concentrating, tiredness, confusion and dizziness (Krecar, Kolega & Kunac, 2014). These symptoms are responsible for the malfunctioning of some chemical substances like neurotransmitters and may alter the blood-brain barrier permeability reducing the flow of blood in certain regions of the brain (Masento, Golightly, Field, Butler & van Reekum, 2014). Besides, suboptimal intake of fluid has been reported to be associated with dysfunction of the dopamine (a catecholamine) and noradrenaline (norepinephrine) systems including the impairment of the choline activities that leads to defective neurotransmission.

Hyperhydration is also frequently seen in individuals who are susceptible to water retention as a common consequence of iatrogen salt and overhydration (Wikinson, Martins & Gough, 2010).

To avoid the impending danger arising from fluid deprivation, generations have utilized fluids from not only water, but from beverages in order to bring the hydration state of individuals to normal or close to normal. However, habitual water intake is more advantageous than the intake of other beverages because it does not contain harmful chemicals or sugar that may contribute to an increase in body weight and the accompanying health morbidity of obesity which may pose threat to human lives. Additionally, the World Health Organization (2020) observed that water is very crucial in the prevention and managements of emerging nutrition-related non-communicable diseases that manifest from the shift towards the consumption of fluids from mainly caloric beverages rather than plain water.

Hydration status can be influenced by several factors such as sex, age, and weather conditions, level of physical activity, dietary habit (e.g. salt intake), health status and metabolism. Ekpenyong and Akpan (2017) identified inadequate consumption of water, drinking of alcoholic beverages, frequent clubbing, being exposed to hot environment, habitual intake of coffee, stresses relating to academics and being a child to parents or guardians who drink and belonging to middle or low socio-economic class as factors that correlate to greater odds of hypohydration among the students. Urine output is a preferred measurement of hydration status; however, fluid intake has often been used due to its convenience and easy measurements (Shirreffs, 2003). Therefore, inadequate production of low volume of urine per day partly suggests that an individual has abnormal hydration state.

1.2 Statement of the Problem

Water is one of the six food nutrients required in macro quantities but its status (hydration status) is rarely assessed compared to other macro nutrients although the consequences of both under and over intake of water might be far reaching, insufficient oral fluid intake is the principal cause of preventable hypohydration/dehydration in humans. Dehydration occurs as a deficit in the water content of the body due to poor consumption or when water intake falls below losses. According to Szinnai, Schachinger, Arnaud, Linder and Keller (2005) insufficient intake of fluid at 1-2% leads to mild dehydration, whereas fluid losses above 5% of the TBW culminated to intense dehydration. In addition, the American College of Sport Medicine (ACSM) indicated that loss of 2% of body mass fluid in hot environment reduced the cardiovascular performance while losses up to 3% of body mass leads to decreased function during cold stress (Sawka et al., 2007).

The consequence of dehydration is fundamental since the minute cells can be affected. Living cells need water to enable them carryout their various functions including regulation of temperature, metabolism, acid-base balance and proper functioning of the whole-body system. Alterations in cellular water content have been reported to significantly affect these bodily activities especially metabolic activities by either increasing or reducing the amount of water in the cells. Increased water in the cell may cause swelling of the cell and activate the production of protein and synthesis of glycogen while reduced water level will lead to reduction in cell size which in turn may encourage the breakdown of glycogen and protein molecules.

Dehydration can be acute or chronic. Acute dehydration has been reported to affect cognition like memory, mood, calculative ability, psychomotor activity, and concentration probably because water is a constituent of the brain. Armstrong, Ganio and Casa (2012) and Popkin *et al*. (2010) found that deficit in fluid intake contributes to less alertness, difficulty in concentration, fatigue

and tension with severe headaches, irritability and sleepiness, increase in body temperature and respiratory rates. Insufficient fluid consumption has deleterious consequences on mood which manifests within few hours (Pross, 2017). This implies that acute dehydration could lead to decreased efficiency in acquisition of knowledge, which in turn could lead to poor performance in examinations. According to Murray (2016) a corresponding supplementation of acute water intervention improved the performance of young adults on tests of attention and short-term memory, indicating that water replacement enhanced the academic performance of the students. Chronic dehydration, on the other hand, is associated with several diseases like neurological disorders, cardiovascular diseases, gastrointestinal, circulatory, chronic kidney diseases and asthma among others (El-Sharkawy et al., 2015; Popkin et al., 2010).

Increased water consumption has a potential protective effect on the development of hyperglycemia. Similarly, when fluid intake is in excess (700–1000 mL/h) such that it exceeds the capacity of the excretion of the kidney, it may lead to severe health challenge or water intoxication and hyponatremia (European Food Safety Authority (EFSA), 2010; Zhang et al., 2017). Water intoxication may cause numerous abnormalities such headache, swelling of brain cell, high pressure of the intracranial, edema of the cerebral, nausea, gradual mental decline, convulsion and even death (Zhang et al., 2017). Hyponatremia is characterized by unusual poor concentration of sodium in the blood below the body's requirement emanating from fluid overload and is not a desirable situation. It also causes nausea, headache, confusion, irritability and muscular pain among others. Hypernatremia on the hand may threaten the life of an individual with health conditions including but not limited to haemorrhage, thrombosis, subdural effusion and cerebral edema (Adrogue & Madias, 2000).

Hypohydration and hyperhydration may co-exist among university students because admission to the university exposes the student to life of independence. This transition period is generally associated with changes in social activities, lifestyle and behavior, dietary habits including fluid intake habits. Available studies on eating habits among university students found low adherence to healthy eating habits. Silva et al. (2016) observed low frequencies of adherence to healthy nutrition practices ranging from addition of salt to prepared foods to low consumption of plant foods such as fruits and vegetables and intake of foods containing large amount of sugar and fat. Low consumption of fruit and vegetable can aggravate low fluid intakes. High and low consumption of fast-food and fruit and vegetable, respectively could increase the risks of low fluid intake. This unhealthy food habits may be compounded by changing fluid intake behaviour.

Poor nutrition in most cases can be attributable to lack of awareness of requirements. Lack of awareness coupled with the students' insensitivity to the day-to-day variability of adequate intake of fluid can increase inappropriate hydration status. It has also been found that even when students are knowledgeable about the necessity of optimum fluid intake that the knowledge does not translate to appropriate practice. Research by Abraham, Noriega and Shin (2018) reported that although majority of college students had good knowledge of healthy nutrition, preference for taste and convenience was among the highest predictors for their nutrition choice.

Data across the globe show that many people including the students have poor hydration status as a result of inadequate fluid intake. Aphamis, Stavrinou, Andreou and Giannaki (2019) showed that 90% of students residing in a hot weather came to school dehydrated and thirst did not stimulate them to drinking adequate fluid. In Los Angeles and New York City 63% and 66% of school children were found to be fluid deficient (Stookey, Brass, Holliday & Arieff, 2012). Another research by Kenney, Long, Cradock and Ciortmarker (2015) reported that out of 4134 US

adolescents and children 54% of them were dehydration. The authors observed that increased consumption of water improved the hydration status of the respondents. In Europe, Nissensohn, Castro-Quezada and Serra-Majem (2013) reported that 5 to 35% of its population had an insufficient water intake while Mete et al. (2017) found that 78.7% of medical students at Inonu University, Turkey consumed less water per day than the recommended intake for their sex and age and the daily intake of drinking water was insufficient for the students. On the other hand, Ibeanu and Lawal (2018) observed that 14.4% and 8.5% of pregnant and lactating mothers, respectively in Lagos State, Nigeria were dehydrated. However, study on hydration status is still a virgin area in many countries including Nigeria. Presently, studies on hydration is championed by the European Hydration Institute aimed at enhancing and disseminating appropriate knowledge in every aspect of human hydration, its negative impact on health, physical performance and wellness.

University students make up a large proportion of Nigerian population and being the society's investment for the future, low hydration status arising from inadequate fluid intake may constitute a major public health concern. There is need to provide evidence-based scientific data on the state of hydration of individuals in communities. Therefore, the goal of this study was to evaluate the hydration status and contribution of water and beverages to total fluid intake of undergraduate students in the first-generation universities in Nigeria.

1.3 Objectives of the Study

Broad Objective

The broad objective of this study was to assess the hydration status and contribution of water and beverages consumption to total fluid intake of undergraduate students in Nigerian universities

Specific Objectives

The specific objectives were to:

1. assess the socio-demographic characteristics of the respondents;

2. assess the frequency and pattern of consumption of water by the students;
3. assess the frequency and pattern of consumption of beverages;
4. identify the factors associated with the consumption of water and beverage among the students;
5. determine the contribution of water to total fluid intake of the students;
6. evaluate contribution of beverages to total fluid intake of the students;
7. assess hydration status of the students and
8. evaluate the correlation between fluid, water and beverage intake of respondents.

1.4 Significance of the Study

The result of this study would be made available to the public through publications in the reputable journals, seminars and workshops as much as possible. It would help the undergraduates especially those in Nigeria in eliminating high risk factors that would predispose them into consumption of beverage and embrace those that would promote water intake. This by extension would aid weight management and enhance academic performance of the students. It would sensitize the students on the importance of intake of enough water to meet up the recommended allowance for their sex and age.

It would increase the knowledge and awareness of the student's on water and beverage intake. It would encourage the students in making better nutrition choices. The result would also help Nutritionist/Dietitians and other health professionals to initiate behavioural change counseling among the populace to promote adequate hydration in all age groups. Data generated from the study would serve as baseline information and encourage further investigation on hydration. The researcher would also benefit from the study by acquiring writing skills that would help her in future academic studies.

CHAPTER TWO

LITERATURE REVIEW

Literature was reviewed under these sub-headings:

2.1 Overview of undergraduate student's lifestyle

2.2 Overview of fluid, water and beverage

2.3 Factors affecting fluid intake and hydration status of humans

2.4 Hydration status and categorization

2.5 Prevalence of hypo and euhydration among university students

2.6 Hydration status, human health and cognition

2.7 Methods of assessing fluid intake status in human

2.8 Methods of assessing hydration status in human

2.1 Overview of undergraduate student's lifestyle

Admission to the university exposes the student to life of independence and brings freedom to the individual who has previously been fully dependent on his/her parents for virtually everything. As a transition period it is generally associated with changes in social activities, lifestyle and behaviour, dietary habits including fluid intake habits. Studies on eating habits among university students found low adherence to healthy eating habits. Silva et al. (2016) observed low rates of adherence to healthy nutrition practices ranging from addition of salt to prepared foods to low consumption of plant products particularly fruits and vegetables in addition to high consumption of foods dense in fat and sugar.

Moreover, studies by Guenther, Dodd, and Reedy (2006) Popkin (2010) and Paeratakul, Ferdinand and Champagne (2003) showed that the diet of young adults is characterized by low fruit and vegetable content and elevated consumption of restaurant fast food and beverages. According to Pelletier, Graham and Laska (2014) high beverage consumption by young people was related to perceived intake by friends and family members while low fruit and vegetable consumption was exclusively associated with only the habitual attitude of friends towards intake of fruits and vegetables.

Frequent fast-food consumption may in turn predispose students to increased beverages and reduced water intake. Similarly, low consumption of fruit and vegetable may aggravate low fluid intakes since their water content is very high resulting in poor hydration status. It has been observed that young adults in the university worldwide and in Nigeria excessively use alcoholic beverage. Adekeye, Adeusi, Chenube, Ahmadu and Sholarin (2015) assessed the use of alcohol and other substances among university student in some private campuses southwestern Nigeria and concluded that 72% of the respondents took alcohol. In another study carried out in Serbia, 77.7% of undergraduates occasionally consumed alcohol while 4.6% consumed alcoholic beverages on daily basis (Višnjić, Jović & Grbeša, 2015).Wicki, Kuntsche and Gmel (2010) reported high prevalence of harmful drinking habit exhibited by undergraduates with a corresponding unawareness that their drinking habits exceed normal levels.

Several factors such as friends influence, studying in the night, desire to do well academically, low mental health status, alcohol availability was identified as the primary contributor to the university students' high prevalence of unhealthy alcohol use (Karam, Kypri & Salamoun, 2007). According to Chu, Jahn, Khan and Kraemer (2016) being female and engaging in less physical activity at least once per week correlated negatively with drinking problem whereas having fathers who are highly educated as well as exposure to stress positively associated with hazardous drinking habit of undergraduates. In addition, demographic characteristics like sex and age, parent's economic background including income and level of education, lifestyle, nutrition consciousness, social activity, and academic stress could also influence students alcoholic drinking habits (Karam, Kypri, & Salamoun, 2007; Baumberg & Anderson, 2006; Bewick et al., 2008).

Other factors may include curiosity, family background, advertisement, low price, large portion sizes and social pressure. A study by Adeoye, Adeoye and Ani (2014) on the prevalence and related factors affecting the intake of alcohol among Babcock undergraduates in Ilishan Remo of Ogun State, Nigeria highlighted that social economic background; emotion and peer influence significantly affect alcohol use. According to the authors, peer pressure influenced the use of alcohol mostly followed by family background and a person's emotional state. On the contrary, Adekeye et al. (2015) observed that a significance difference exists between age of students' and drinking of alcoholic beverages and other related substances while the WHO (2012) attributed the Nigeria situation in the last decade to the increase of alcohol production and importation which have influenced all people at different ages. Globally, undergraduates consume alcohol more than their peers who are not on campuses (Kypri, Cronin & Wright, 2005).

2.2 Overview of fluid, water and beverage

Fluid refers to a substance which has the capability to flow or alter its shape by the application of stress and it represents a fraction of a form of matter, that is, liquids, gases and plasma (Marie, 2019). According to Shepherd (2011) approximately 52% and 60% of the total body weight of women and men, respectively are made up of fluid. Welch (2010) reported that the amount of fluid consumed is expected to be equal to the amount excreted for the body to achieve a state of fluid balance that allows the body to carry out its basic metabolic functions as effectively as possible. Fluid volumes in human body are broadly distributed into three compartments; namely the total body fluid volume (TBFV), intracellular fluid volume (ICFV) and extracellular fluid (ECFV).

Total body fluid comprises of plain water and other molecules containing dissolved compounds like sodium chloride (electrolytes) (Jain, 2015; Schmidt, 2010). The ICFV compartment is made up of fluid found in the cytoplasma located inside cells while the ECFV represents all body fluid

contained outside the cells. The ECFV can be subdivided into two compartments as interstitial and intravascular (blood plasma volume). Interstitial fluid otherwise known as tissue fluid surrounds and bathes the body cells. It contains about two- third and of the ECFV whereas the blood plasma contains about one-third of the amount of fluid outside the cells. The blood plasma is the liquid constituent of the blood which holds cells of the blood and other various molecules in suspension.

Transcelluar fluid refers to the proportion of total body fluid located in the spaces lining the epithelial which consists of fluid in the cerebrospinal, the eyes (the humors), the joints, those within the vessels of the lymphatic system (the lymph), synovial, peritoneal and pleural fluids (Day et al, 2009). Transcelluar fluid makes up nearly 7% of the total water in the body. Others ECFV include fluid secreted by glands, the digestive tract, skin, kidneys and saliva which exist within the spaces between cells. Of all these volumes ICFV contains more than half 57% of the overall water in the body while the extracellular fluid volume makes up the remaining about 43% of the total fluid in the body (Bhave& Neilson, 2011) (Docherty and McIntyre, 2002). According to Wang et al. (1992a) the body of a 70 kg male will have approximately 42 litres of water with 28 litres located in the intracellular part; 14 litres in the extracellular and 3.1 litres in the plasma. Although fluids in the body are found in various compartments, they constantly move from one compartment to another with the aid of the cell membrane under certain forces such as hydrostatic, osmotic and oncotic forces.

Fluid intake and output determine hydration status of an individual. Under normal conditions, when individuals consume enough fluid, euhydration is maintained but when insufficient fluid is consumed; there would be hypohydration/dehydration. In the same vein, when fluid in the body becomes excessively high, hyperhydration or overhydration results. Hypohydration and hyperhydration depict derangement in hydration status and are harmful to the body system. The availability of water will directly or indirectly impact on hydration status of a population.

Practically, individuals tend to consume more of what is available and less of what is out of reach. Daily fluid intake and requirement varies from person to person. The recommended intake of fluid for infants is about 3 cups (750 ml) per day for a six-month-old infant and this quantity is usually supplied by human milk (Smloin et al., 2003).

Several authorities including the European Food Safety Authority (EFSA), the World Health Organization as well as the Institute of Medicine (IOM) have made recommendations about the adequate intake (AI) of fluid, nevertheless, their opinions are not generally acceptable because people are not certain concerning the actual fluid need (Gibson, Gunn & Maughan, 2012). Apart from limited empirical data on the actual extra fluid individual should consume (Cohen, 2012) there is also a wide variability of fluid requirements among individuals. Armstrong (2005) suggested that rather than concentrating on the actual fluid requirement of the body, people need to be concerned about monitoring and evaluating the level of fluid (hydration state) in their body utilizing some biomarkers such as specific gravity and colour of the urine. Human body drives its fluid from three principal sources namely: foods, beverages (plain water and other beverages) and metabolism.

Table 1: Recommendations for total water intake for different age-groups (L/day)

		EFSA (2010) DRV		IOM (2005) AI		WHO (2003) R	
Children	Age (years)	Male	Female	Male	Female	Male	Female
	1-2	1.1	1.1	1.3	1.3	1.0	1.0
	2–3	1.3	1.3	1.3	1.3	1.0	1.0
	4–8	1.6	1.6	1.7	1.7		
	9–13	2.1	1.9	2.4	2.1		
	14–18	2.5	2.0	3.3	2.3		
Adults	19–50	2.5	2.0	3.7	2.7	2.9	2.2
	19 and above	2.5	2.0	3.7	2.7	2.9	2.2

Source: Gibson et al. (2012); DRV = daily reference values; AI = adequate intake; R= requirement

Water is a clear liquid, without taste and it is essential to survival. Depending on how much fat is stored, an average adult may live for about two months without eating any food but only few days to survive when deprived of water (Smolin et al., 2003). This is because water cannot be stored in the body like other nutrients, yet it occupies almost the large proportion (50-70%) of the total weight of the body (Wardlaw, 1999). Water is the most important substance after oxygen. Its intake is a preferred way to quench thirst. Drinkable water can be obtained from various sources including tap, still, bottled and sparkling and others. Drinkable water needs to be safe from contamination. According to Senterre et al. (2014) and Parket al. (2012) a minimum of 55% of the fluid requirement needed to achieve euhydration is expected to come from plain water. In addition, Park et al. (2012) reported that individuals can maintain normal levels of hydration when they drink water for not less than 3 to 4 times within a day because intake of water below 3 times

per day may be referred to as low intake and this is substantially related to inadequate state of hydration.

Water performs several vital functions in the body notably transportation of oxygen and nutrients from the blood to the cells and the removal of waste products like urea and other nitrogen-containing products. Water serves as a preferred solvent for many substances because it is a polar liquid having different electric charges at the two sides. This polar nature of water makes it possible to surround and dissociate other electrically charged molecules. It also serves as a lubricant in the eyes, joints, and mouth. Water is required for several chemical reactions in the body like in hydrolysis and condensation reaction as well as in acid- base balance.

Water contains zero-calorie, hence, can be employed for weight management programme, prevention of potential adverse effects of dental caries, obesity and type 2 diabetes (Tate et al., 2012; Armfield, Spencer, Roberts-Thomson & Plastow, 2013, de Ruyter, Olthof, Seidell & Katan, 2012). Athanasatou et al. (2016) found that most (78% for males, 80% for females and 78% for the total sample) of Grecian adults consumed water more than other beverages with hot beverages being next to water followed by alcohols and milk. In another study 46.6% of men and 48.2% of women consumed water compared to other beverages. The second contributor was hot beverages (30.2% for women and 23.5% for men). Fluid intake research among normal children, adolescents and adults in France demonstrated that water represented approximately half of the fluid intake of the respondents on daily basis. Consequently, water constitutes the largest portion of fluid consumed across various age groups.

Guelinckx et al. (2015) compared the consumption of water and various beverages among a sample of adult population in thirteen countries namely: Argentina, Brazil, China, France,

Germany, Iran, Japan, Indonesia, Mexico, Poland, Spain, Turkey and United Kingdom. They found that water contributed the greatest amount (47-78 %) of the total fluid intake of participants from China, France, Iran, Turkey, Indonesia and Spain, followed by hot beverages (28-50%) in Germany, UK, Poland and water (18-32 %) for those in Japan. For participants from Argentina, Brazil and Mexico regular sugar beverage and juices contributed the highest amount (28-41%) of the TFI and this amount was almost equivalent to the 17-39% supplied by water. According to Nissensohn et al. (2013) a typical Western diet contributes to approximately 20-30% of fluid and 70-80% is obtained from drinking of fluids.

Little alteration in the amount of body water can threaten an individual's life. Therefore, increased water losses particularly during hot weather and with increased physical activity should be followed with intakes to compensate for the loss and maintain homeostasis. Homeostasis is achieved when body water is in a state of equilibrium (i.e. when water intakes equals to water losses from the body). Water input represents the total water ingested from beverages plus the water from ingested food and metabolic water (Shirreffs, 2003; Benelam & Wyness, 2010). An equilibrium in daily intake of water is established when the amount of losses is equivalent to the amount gained. Generally, about 5% to 10% of the bodily water is produced and used up through obligatory or non-exercise fluid loss channels (Institute of Medicine, 2005).

Under normal physiological conditions, body water loss principally comprises fluid excreted from the urine, and to a lesser degree from respiratory water, feces, and skin sweat (EFSA, 2010; Athanasatou et al. 2016) and vomiting. According to (Manz & Wentz, 2003) urinary mean volume in adults usually ranges from 1 to 2 L/d but decreased fluid intake gradually reduces urinary volume. Water losses from the skin may occur either through sweating and/or insensible loss of water.

Sweating is a process by which water and other substances are excreted through the sweat glands. On the contrary, insensible loss of water contains no dissolved solute and is also known as evaporation of water through the respiratory tract and via the skin by simple passive diffusion. Under normal environmental conditions and inactive lifestyle, sweating occurs at a slow rate (EFSA, 2010). Accordingly, water loss should be replaced by regular consumption of fluid and food at various intervals during the day to cushion the effect of dehydration.

Normally, when the usual low rate of water losses, which happen through the lungs, skin and intestine are maintained, adults are expected to take 1.5 to 2.5 litres of water to produce 1-2 litres of urine every day (Madias & Adrogue, 2005). Although there may be little variations in the amount of water contained in the body throughout the day with no feasible consequence on the either the health or physical performance on the individual. Waugh (2007) reported that thirst is a natural regulator to fluid reduction with a corresponding depletion of salivary secretion and dried oral mucosa. Water balance in human body is regulated by various organs and processes:

The kidneys: These are vital organs actively involved in the regulation of the amount and content in the extracellular fluid of the body through series of neuroendocrine mechanisms (Andreoli, Reeves & Bichet, 2000). Their major role is to selectively excrete metabolic wastes products; stabilize the appropriate bodily compositions such as fluid and electrolytes in order to maintain the normal composition of the blood. Each day, the kidneys filter the blood more than 50 times representing 180 litres (Groff, Gropper & Hunt, 1995). Apart from this, they help in the maintenance of electrolytes balance as well as water balance. Kidneys can reabsorb or eliminate water based on body's needs. Several hormones such as antidiuretic hormone (ADH), aldosterone and natriuretic factors target the kidneys and help them in accomplishing this function.

The ADH or vasopressin is a hormone which conserves water by enhancing its permeability to allow the capillaries of the kidney to reabsorb water. It further participates in the processes that stimulate the thirst sensation (Groff et al., 1995). Aldosterone stimulates the active reabsorption of sodium ions by kidney thereby increasing the extracellular fluid osmolarity and promoting fluid retention by the body (Groff et al., 1995). Consequently, there may be very large differences in the fluid produced by the kidneys in attempt to keep the total body fluid constant depending on the specific amounts of macronutrient, level of water and sodium although these conservation and excretion are done with limitations. The antidiuretic hormone and aldosterone help to regulate both shortage and excess of water.

Thirst mechanism: Thirst is critical in the restoration of water equilibrium through the inducement of the urge to consume fluid when water losses are more than water intake. However, optimum hydration cannot be assured only by prompt response to thirst mechanism and willful drinking (Rowland, 2011). According to Rowland (2011) humans when left to choose, lack the capacity to consume adequate fluid to completely replace fluid loss after dehydration stimuli.

Thermoregulation of body fluid: The body maintains water balance also by regulating temperature changes in the external surroundings. When the temperature of the body rises, as seen in the case of fever, the skin dilates leading to the flow of blood towards the body surface in order to release heat to the outer surroundings. The reverse of this happens with cooled weather where the blood vessels in the skin become tighter and narrower resisting the flow of blood towards the body surface in order to conserve heat. This regulation is important as any abnormality can be life threatening. Smolin et al. (2003) stated that normal body temperature is tightly maintained at about 37^{o}C because an increase above 40^{o}C or decrease below 30^{o}C will likely terminate the life of a person. This happens to ensure that excessive water is not lost through sweat.

Beverages also contribute to the household food nutrition in general and specifically to body hydration. They contain varying amounts of water and as a consequent; their contribution to the total fluid intake of an individual will vary depending on the type of beverage consumed. Basically, there are two types of beverage namely alcoholic and non-alcoholic beverages. Alcoholic beverages contain alcohol or ethanol and can be classified into subunits including beers, alcoholic wines and spirits. The percentage by volume (% volume) of ethanol content of alcoholic beverages serves as a measure of the level of ethanol composition of the beverage.

This varies from one alcoholic drink to another and may also differ from one country to another. According to the International Agency for Research on Cancer (2010) beer contains 4–5% ethanol by volume; wine 12% while distilled spirits about 40%. However, some alcoholic beverages may contain lower or higher ethanol. Beer may contain ethanol content in the range of 2.3% to more than 10%, however alcoholic beverages manufactured at home or locally made like sorghum beer may have lower alcohol content. The range in wine is from 8% to 15% and around 20% volume to over 40% in spirits.

Non-alcoholic beverages contain no alcohol or less than 0.5% alcohol by volume. Non-alcoholic beverages according to Han and Powell (2013) include those beverages such as non-diet, non-alcoholic drinks that contain additional sugar. They are commonly known as sweetened beverages. Figure 1 shows samples of sweetened beverages consumed in Nigeria

Fig 1: Popular beverages consumed in Nigeria

Source: Alaine (2019)

A study by Fadupin, Ogunkunle and Gabriel (2014) on the assessment of the knowledge, attitude and consumption pattern of alcoholic and sweetened beverages among undergraduate students in Ibadan Nigeria found that a good number (85.4%) of them showed a positive attitude towards alcohol intake irrespective of their optimum awareness of the negative health impact accompanying alcoholic beverage consumption. Similar work done in the UK by Warner and Ha (2017) reported differences between knowledge categories and consumption of sweetened beverages. According to the authors, 59.6% of the students had adequate knowledge of sweetened beverage and 73% were consumers.

In Spain, where Mediterranean Diet is widely practiced, Nissensohn et al. (2016) highlighted that the pattern of fluid consumption constituted mainly water and beverages. Among all the beverages studied, both male and female respondents usually took water and milk. However, men drank more alcoholic drinks followed by caloric soft drinks, which was next to hot beverages, with similar percentages of 11%, 11%, and 10%, respectively. In the case of the women, hot beverages were mostly (12%) taken followed by caloric soft drinks (8%), and lastly alcoholic

drinks (5%). Both genders took lower levels of healthy drinks like fruit and vegetable juices and diet soft drinks.

2.3 Factors affecting fluid intake and hydration status of humans

The adequate intake (AI) value of fluid and hydration status of humans differ because of the inter-individual variations for fluid requirement coupled with difference responses of heath state, metabolic activities, factors relating to weather condition (i.e., variations in ambient temperature and humidity), some individual peculiarities such as age, body size, and level of exercise, overall diet and the water contained in foods (Nissensohn et al., 2016). Ekpenyong et al. (2017) identified inadequate intake of water, regular consumption of alcoholic beverages and frequent attendance of night clubs, constant consumption of coffee, high academic workload as well as belonging to a family of low or middle socio-economic possessions as factors that correlated with high odds of abnormal hydration among the students.

Age and fluid intake: According to Smolin et al. (2003) infant requires proportionally higher fluid than adults because the infant kidney cannot concentrate urine effectively as adult and hence, loose more urine than adults. Consequently, infants have more severe consequences to the effect of hypohydration. Nissensohn et al. (2016) assessed the beverage consumption habits and association with total water and energy intakes in the Spanish population and found that the contributions of water from various sources differed. In that study, water contribution from food rose as their age increased from 434g/day among 13–17year old participants to 584g/day among the 65–75year old, while the contribution of water from beverages decreased from 1202g/day among adults aged 18–64 years to 1002g/day for older adults. Park, Bettylou, Nancy, Brener and O'Toole(2012) found a prevalence of 54% low water intake of less than 3 times per day with substantial risk among students less than 15 years of age.

Gender and fluid intake: Water is the major constituent by weight and volume in the human body and the percentage volume of water in different genders is not the same**.** In a Korean National Health and Nutrition Examination Survey (2007-2010) of South Korean adolescents on the factors associated with low water intake, Lee, Park & Kim (2014) found that being female and not meeting the recommended physical activity level (≥ 20 min/day on greater than 3 days /week) were factors that significantly related to low water intakes (below 4 cups) in a day. Most (57.3%) of the dehydrated respondents according to the authors produced less quality of urine of which 38.6% had deep yellow urine and 36.6% amber. Nissensohn et al. (2016) assessed the beverage consumption habits and association with total water and energy intakes in the Spanish population. They found that more males significantly took water and beverages compared with females, however, none of the gender drank optimally to meet the requirement set by EFSA reference level. Men consumed nearly 33% less fluid while women took about 21% less fluid than the AI.

Body composition and fluid intake: Malnutrition including over- and underweight has been found to correlate significantly with suboptimal intake of water especially when intake was as low as below 4 cups per day **(**Lee et al., 2014). This study suggested that abnormalities in nutritional status may not be related to inadequate fluids consumption and vice versa. Normal BMI correlated with low water intake.

Physical activity/exercise and fluid intake: Level of activity affect the amount of fluid consumed by humans by increasing the loss of water through the respiratory tract resulting from the raised volume of the respiratory tract as well as increase in the rate of breathing. It has been observed that many people are no longer active. Park (2009) reported low physical activity among students who tend to replace even their leisure time for academic progress limiting other major non-academic activities like exercising. One of the factors that greatly contributed to the insufficient intake of water (i.e., < 4 cups per day) was reported to be inadequate consumption of

water or lack of exercise that did not meet the required recommendations of 20minutes each day for three or more days every week (Lee et al., 2014).

Environmental conditions and fluid intake: Environmental conditions like humidity, atmospheric pressure, radiation, and temperature influence fluid intake through sweating and urinary water loss (Greenleaf et al., 1979). Inadequate fluid consumption during hot or cold weather conditions had various implications on the students' cognition. According to Omone and Kozlovziky (2019) during summer season 42.1% of students performed poorly, 30.0% were on the average mark and 27.9% scored higher than average as opposed by higher percentage of academic performance during winter with few (18.9%)of students scoring less than average 38.1%being on the average and 43.0% scoring greater than average.

Salt and fluid intake: On the average, a normal adult under an average weather condition requires approximately 1ml of water per kilocalorie of energy expended or about 2 to 3L per day (Smolin et al., 2003). The study of Park et al. (2012) among high school students in USA revealed that consumption of less than two (2) glasses of milk a day, intake of non-diet soda and other beverages with added sugar once or more times per day, consumption of fruits and 100% fruit juice less than twice daily and intake of vegetables less than three times per day were among the foremost factors that significantly contributed to insufficient intake of water in adolescent population. Others include frequent eating of food prepared outside the home for 1 to 2 days in a week and greater than three days weekly coupled with sedentary lifestyle above 60 minutes per day or less than five days in a week.

While the consumption of soda, coffee, fruit, vegetable, salt and eating food outside home were not statistically significant with inadequate water consumption (drinking of less than 4 cups of water daily) or very much lower consumption (i.e., drinking less than 2.5 cups daily), high intake of water correlated with rise in the consumption of milk, sport drink, fruits, vegetables, physical

activity, and reduced consumption of non-diet soda and frequent eating in restaurants. The authors therefore concluded that deficit in the quality of diet and increased rate of eating fast-foods are related to low water intake. Kant and Graubard (2010) further found an inverse relationship between the consumption of plain water and that of total sugar among the USA children and adolescents aged 2-19 years.

Thirst and fluid intake: Again, the functionality of thirst bud can affect fluid intake of individuals: Thirst is stimulated by the thirst centre in the brain whenever the body experiences a decrease of water in the blood or high concentrations of dissolved substances in the blood. Thirst sometimes will determine how much fluid a person can take at a time and thirst is quenched almost immediately after fluid intake. Decreased levels of fluid intake in the blood could have notable signs like dry mouth and reduced secretion of saliva, which prompts an individual to drink water. The decline in the sensitivity of the taste buds in the elderly might not allow them to appropriately detect these signs and the corresponding loss of fluid. Although these signals may contribute to the overall regulation of water intake, they may not be the perfect determinants of fluid intake. According to Smolin et al. (2003) thirst sensation delays water requirement especially in individuals having fever, vomiting, or diarrhea. These health conditions may not prompt people to have the desire to drink water though they are losing water rapidly.

Physiological factors affecting fluid intake: External factors can influence the internal physiological state, which in turn can modify drinking. According to Adolph (1967) there are three major events that influence drinking. They are: hypohydration, excess of osmoles and consumption of dry food (prandial). In humans with normal hydration (euhydration), loss of fluid should stimulate a corresponding intake of the same amount of fluid lost. This is because fluid volume of the body constantly changes due to urine and insensible losses and gained intermittently in foods and drinks. Drinking is the only practical way of alleviating hypohydration.

Ingestion of hyperosmotic solutions greater than 290 mosmol/kg of salt (NaCl) induces drinking of fluid volume proportional to the concentration of the salt (Greenleaf et al., 1979). If the salt solutions are given through a stomach tube so that the swallowing mechanism is bypassed, a smaller volume of fluid is consumed more slowly, and the volume of water consumed is usually less than the volume needed to dilute the hyperosmotic solutions to isosmoticity.

Consumption of fluids containing osmotic substances that do not penetrate cells easily (NaCl and KCl) provoke greater drinking than does consumption of equivalent fluids containing substances that do penetrate cells (sucrose and urea). Generally, the presence of solutes in a state of hyperosmotic condition leads to a corresponding increase in the amount of water consumed to help dissolve the high concentration of solutes while that of hypoosmotic decreases water intake. In addition, hyperosmotic concentrations need more water to get rid of the extra solute from the body system. The intake of food may induce drinking under two conditions: First, when dry food is eaten, drinking is promoted to dilute the food; when moist food is eaten, a smaller drinking response is provoked.

2.4 Hydration status and categorization

Hydration status is the measure of the amount of fluid in the body. Students and all humans need to be adequately hydrated to survive. Hydration status can be categorized into three groups as: euhydration, hypohydration and hyperhydration. Euhydration is the term used to describe a state of normal fluid composition, hypohydration refers to a decrease in the fluid content of the body owing to fluid losses exceeding fluid intake, and hyperhydration represents an increase in the fluid contents of the body when fluid intake is in excess of the body's requirements. The state of hypohydration and hyperhydration should not be encouraged as they are associated with potential health problems.

Euhydration: Gibson et al. (2012) defined euhydration as the maintenance of a balance between the amount of fluid loss and gain in human body.

Hypohydration or dehydration: According to Begum and Johnson (2010) hypohydration has no definite definition, but basically refers to a state of reduced level of water culminating from too much loss of body fluid, deceased consumption of fluid or both. It may also be defined as loss of one percent or more of the total body weight resulting from loss of fluid in which the available water is below the minimum amount required for it to carryout its basic functions (Madden, 2000). It has been implicated in several health challenges such as poor academic performance (Patel et al., 2014; Lee et al., 2014). It is often accompanied by altered levels of electrolytes such as potassium and sodium particularly dysnatremias. Based on the concentration of electrolytes, dehydration can be classified into hypertonic, hypotonic and isotonic dehydration.

Hypertonic dehydration is the indiscriminate loss of water than sodium from the extracellular fluid section and it usually occurs in the elderly with reduced thirst sensitivity. It can be caused by diseases like dehydration, high blood sugar, diabetes insipidus, sweating, osmotic laxatives, polyuric phase post-acute, loop diuretics, tubular necrosis, osmotic diuretics, and tachypnea. Hypotonic dehydration presents as the inverse of hypertonic dehydration when sodium loss is greater than water loss as observed in burn victims or when diuretics are used to treat patients. Other causes are vomiting, diarrhea, enterocutaneous fistula, renal failure, adrenocortical deficiency and cerebral salt wasting. Isotonic dehydration occurs from the equivalent loss of both water and sodium, which in turn gives rise to normal level of sodium in the blood and this, can be seen in a disease such as diarrhea. The risk factors are burns, vomiting, diarrhea and ascites.

Dehydration has many physical signs and symptoms including increased thirst, little or no urine production, dark or yellow urine; unexpected loss of weight, dryness of the mouth, sunken eye

that cannot easily produce tears, sagging of the soft spot in infants, inability of the skin to stretch, alteration of the cognitive performance; decreased physical activity; headaches, and weakness (Welch, 2010). According to Large (2005) severe dehydration is associated with a drop in the amount of blood flowing in the body and may lead to hypotension, hachycardia, fatigue, thready pulse, cold hands and feet, and Oliguria (reduced urine production). The Consequences of hypohyration are common to all age groups, however, it is more dangerous during ill health, in children and the elderly because illnesses distort the body's water equilibrium and induce dehydration or overhydration.

Overhydration/hyperhydration: This occurs when there is improper administration of intravenous fluids that exceeds the kidney's capability. Chronic to mild overhydration is regarded as harmless but can lead to hyponatremia (abnormally low levels of sodium in the blood. Ayus, Negri, Kalantar-Zadeh & Moritz, 2012; Ayus and Moritz, (2010) showed that hyponatremia may increase the risk for falls and fractures among the vulnerable group particularly the elderly.

Acute severe overhydration is an uncommon health condition attributed to an excessive consumption of plain water over the need of the body accompanied by a reduced level of electrolytes which renders the kidneys incapacitated to compensate with the increased urine output. Few studies have observed that athletics who usually subject themselves to excessive running and other long-lasting sport activities mostly die due to acute severe overhydration every year (Tyrwhitt-Drake, Ferragud & de Andrés, 2014). This results from a disturbance in the balance between water and electrolyte in the intracellular spaces making the cells to absorb water and swell. According to Moritz (2003) if it happens in the brain, it may lead to a rise in intracranial pressure and if not reversed can restrict the flow of blood to the brain causing seizures, coma or even death.

2.5 Prevalence of hypo and euhydration among university students

The prevalence of hypohydration/dehydration in the general population and university students is well documented. Ekpenyong et al. (2017) investigation on the health implications and academic performance on the high prevalence and associated risk factors of dehydration among college students aged 18-35 years in Uyo, Akwa Ibom, Nigeria. They found the prevalence of dehydration to be 46.4% using USG >1.020 as a cut-off for urine specific gravity, whereas more than half of the respondents (53.6%) had normal hydration. This study demonstrated that the number of students having normal hydration was slightly higher than those who had suboptimal hydration and this might have negative effect on the students' academic performance. In another study titled validation of beverage intake methods versus hydration biomarker, Nissensohn et al. (2016) found that 75% of their participants were dehydrated in comparison with adequate water intake set by the European Food Safety Authority (EFSA). Senterre et al. (2014) found that most (91.5%) of children in Belgium in Europe failed to meet the adequate water intake for their sex and age.

2.6 Hydration status, human health and cognition

Studies have linked optimum water intake to the aversion and treatment of certain health conditions (Strippoli et al., 2011; Enhorning, Hedblad, Nilsson, Engstrom, & Melander, 2015; Clark et al., 2016; Fresan et al., 2016). The American Heart Association and American Stroke Association (2015) defined adequate hydration as urine osmolality < 800 mOsm/kg. Alterations in the normal fluid composition in the body lead to undesirable modifications in both the tissues and cells, which by extension causes disturbances in their normal functions (Lang, 2011). According to Faria, Mendes and Sumita (2017) osmolality is the number of osmoles of solutes per kilogram of water.

Disturbances in cellular and tissue functions may present varying degrees of abnormal health conditions. The Oxford Centre for Evidence Based Medicine (2009) reported that suboptimal hydration status can cause health challenges like urological disorders, urinary tract infections (UTIs), urolithiasis, chronic kidney disease, bladder cancer, gastrointestinal functional (constipation), colorectal cancer, circulatory disorders, cerebral infarct, coronary heart disease, orthostatic hypotension, neurological problem, headache, metabolic disorders, diabetes mellitus, obesity, respiratory disorders, pregnancy, labour and breastfeeding oligohydramnios. In addition, dental disorders, hypertension, gallstones, breast cancer, iatrogenic fluid overload, bowel dysfunction in surgical patients, and overhydration in athletes may also manifest as a result of abnormal hydration.

Similarly, hydration status can impact negatively on learning ability. This is partly because water constitutes a reasonable portion of the brain, the centre for learning. Any alteration in its water content may significantly affect its function. According to de Jager et al. (2014) and Feist and Rosenberg (2009) cognition encompass all the processes that involve the mental part of the human body that aid in perception, thinking and remembrance, feeling of emotions (mood) and manage their external surroundings and is necessary in every activity of humans. Cognitive performance comprises attention, memory (including short-term, long-term, and working memory), learning, speaking, carrying out executive functions (like reasoning, planning, making decision), visual and psychomotor functions (de Jager et al. 2014; EFSA 2011; Institute of Medicine, 2004). According to the Institute of Medicine (2004) and Masento, Golightly, Field, Butler and van Reekum (2014) mood includes feelings and emotions like happiness, tension, vigor and/or calmness, perceptions like overall mood, sensation of fatigue or headaches, perceived difficulty to concentrate or to perform a task.

Numerous findings on the association between hydration status and cognition demonstrated that inadequate fluid in the body is deleterious to cognitive performance and leads to poor academic performance among students (Patel et al., 2014; Lee et al. 2014). The cognitive performances affected by low fluid intake are short-term memory (Benefer, Corfe, Russell, Short & Barker, 2013), psychomotor skills, vigilant attention, choice reactions, and perceptive discrimination (Edmonds, Crombie, Ballieux, Gardner & Dawkins, 2013). Lieberman (2007) found that one of the uncommon characteristics of dehydration is that it may cause appreciable abnormalities in the electrolyte balance that could change the neurotransmission of the brain leading to deleterious effect on the function of the neuron. Thus, not only does hydration state affect health, it also affects how people think, feel, and perform several functions requiring mental performance.

2.7 Methods of assessing fluid intake status in human

Fluid intake can be determined using different dietary methods such as single and multiple 24-hour recalls, food frequency questionnaire and food diaries (Ozen, 2015). However, assessment of fluid intake with a 7-day fluid-specific diary is the preferred methods and had an edge over other methods because of its accuracy. A recent study by Bardosono, Monrozier and Permadhi (2015) involving 600 adults and adolescents highlighted that there was a significance difference in the estimation of total fluid intake (TFI) obtained from 24-hour recall and that of a 7-day fluid-specific diary. Despite the fact that little level of correlation existed between these two methods, the twenty-four-hour dietary recall was reported to reduce the actual fluid intake by as much as 382ml.

The 7-day diary recorded 2 more drinking occasions and this may be attributable to the fact that the 24 diaries mainly measures the nutrients intake in foods and not fluid. Again, it is structured around meals which do not capture drinking occasions in between meals. The implication of this

is that studies utilizing the 24-hour recall to assess fluid intake will generate TFI that will provide inconsistent data. This study is intended to use the 7-day fluid-specific diary to assess the total fluid intake among students in order to minimize some of these shortcomings.

2.8 Methods of assessing hydration status in human

There are many techniques that can be used to assess the hydration status of humans and these methods are explained as follows:

Plasma osmolality: This parameter is mostly utilized by many authors. It is the level of dissolved elements present in the blood that measures the intracellular osmolality. It is regarded as a standard technique for the assessment of hydration state and as such, it is used in clinical settings to diagnose dehydration. Measuring the plasma osmolality for hydration assessment uses the instrument known as osmometer or alternatively calculated from the equation 2 X Na^+ + Urea + Glucose (Baron, Courbebaisse, Lepicard & Friedlander, 2015). This formula is developed because sodium is the electrolyte that is mostly found in addition to other two negatively charged elements (anions) which are glucose and urea.

The osmolality of plasma is usually determined by these electrolytes except in pathological conditions involving diabetes and/or end stage renal disorder, which leads to increased ureamia. Sodium concentration can be used as an alternative to determine plasma osmolality because it is equals to plasma osmolality (Costa, Teixeira & Rama, 2013). In physiological conditions where plasma osmolality may not be easily measured, osmolality calculations could replace the use of osmometer. It is cheap, fast, and requires little technical experience; not time consuming and moderately accurate. The major disadvantage of this method is that it is invasive and may be difficult for survey research works due to the tedious nature of blood collections from the subjects.

Saliva parameters: Saliva is another body fluid that is easily accessible for assessing hydration status in humans. Among all the salivary parameters, flow rate is often employed. Research findings have shown that the rate of flow of the saliva is approximately 0·46ml/min and 0·32ml/min, respectively in normal and physiological conditions (Osailan, Pramanik & Shirlaw (2012); Saeves, Reseland & Kvam, 2012). According to Ship and Fischer (1997) dehydration occurring within a day contributed to reduced rate of flow of saliva among healthy adults, though the sample size used in the study was small. Although the rehydration of the subjects improved their rate of saliva flow, it was still substantially below the initial level of flow. Therefore, the osmolality of the saliva is of great importance in the evaluation of hydration status of individuals.

Cheuvront et al. (2010) examined the normal hydration state (persons who are euhydrated) of a small population (18 persons) and found that the normal value of saliva osmolality is 71mOsm/kg. Singh and Peters (2013) found no association among the osmolality of the saliva, osmolality of the urine and the urine specific gravity among persons carrying out different activities of the day. Although researchers have successively measured hydration status in small samples, it is not easy with larger population sizes because there are wide individual variations (inter-individual variation coefficient of up to 35·8%) that requires the measurements of the subjects' baseline hydration value first to serve as that subject's point of reference (Ely, Cheuvront & Kenefick (2011); Walsh, Laing & Oliver (2004) and Cheuvront et al. (2010).

Again, the baseline value is not easy to obtain because of wide differences (intra-individual variability of 9·5%) that exist even within an individual. In terms of the sensitivity of these techniques, the osmolality of the saliva has the least sensitivity (81%) with (83%) specific hydration status marker (Cheuvrontet al., 2010). Conclusively, despite the fact that the measurement of osmolality of the saliva is not invasive and inexpensive, it is not suitable for use

with persons suspected to be at the risk of dehydration and in large population because it is not accurate, requires an expert coupled with its large inter-individual and intra-individual variations.

Isotope dilution/tracer method: This is known as stable isotopes administered to an individual either orally or intravenously (Watkins, Lightbody, Theofanidis & Sharma, 1997) in order to ascertain the hydration status. The method is guided by the idea that water frequently move from one section of the body fluid compartment to another and that isotope tracers will be distributed equally in these fluids if left for enough time (3-4hours) to enable the tracers to completely enter into all the compartments. The fluid volume is determined from an equation: PV1 x PV1 = PV2 x PC2. Where PV =plasma volume, PC= plasma concentration. The equation makes it possible to directly measure fluid in all the fluid compartments including the entire water in the body, that is, the water inside and outside the body cells.

Isotope tracers take into consideration the physical properties of tracers during this calculation to avoid errors. The isotopes tracers used for the calculation of TBW for instance should have the ability to freely enter all the body compartments, while those used for assessing the extracellular compartment consist of tracers that can only enter the extracellular compartment. Hydrogen isotopes such as deuterium (^{2}H), deuterium oxide ($^{2}H_2O$) and oxygen-18 (^{18}O) are popularly used (Bak et al., 2017) because they have the ability to replace hydrogen and oxygen in the body during normal biochemical and metabolic reactions as well as spread out like water.

Highly radioactive traces used in the past have now been replaced with less harmful ones because of their adverse effect on the subjects. Similarly, isotopes tracers that can easily dissolve in organic solvents like bromides are being substituted with other one as they can be absorbed from the GI tract (Bak et al., 2017). One of the greatest advantages of this technique is that it can be

used to directly determine the fluid compartments. However, it is limited only to research laboratories that allow many internal and external environmental factors to be controlled.

In clinical setting isotope tracers may not be applicable not only because these factors cannot be controlled but also because clinical settings require repetitive assessment couple with the fact that quick result is needed. Besides, their administrations are expensive, take long time to be analyzed, complicated and require special professionalism. It may therefore pose a challenge to clinical, laboratory as well as studies involving large population. The hazardous nature of radioactive tracers would not allow for repetitive assessment which is usually needed in clinical settings. Although this method can be used to accurately determine hydration status, it cannot distinguish normal hydration status from dehydration or overhydration.

Neutron activation analysis (NAA) method: This method assesses the hydration status of people by exposing to them to reduced levels of nuclear irradiation. This mechanism produces reactive radionuclides which give out rays having specific feature in the process of their decays (Rolls & Phillips, 1990).The decay pathways of most elements have been known and could serve as a standard for measuring the actual level of every substance in the reactive radionuclides. In addition, some elements have been identified as being concentrated mainly to certain body compartments. Potassium occupies up to ninety-eight percent (98%) of the elements found in the intracellular volume whereas chlorine occupies 90% of the extracellular volume of the fluid in the body.

Yasumura, Cohn and Ellis (1983) conducted a research to validate the relevance of NAA method in the assessment of hydration state of humans against the isotope tracer's method and demonstrated a strong relationship between them; and its superiority over the isotope method as

NAA takes less time and it is noninvasive. Its major disadvantages however are: it needs a specialist instrument and high technical expertise that is not easily accessible and affordable by many research institutes; it cannot be used in studies that require repetitions of assessment or help to give the threshold figure for deviations from normal hydration status like the isotope tracers.

Bioelectrical impedance analysis (BIA) method: This is usually employed in the estimation of the water content of the body. Its principle depends on the fact that body tissues can conduct electrical current when mild electric current is passed through them. The conductivity which corresponds to the water and the electrolyte content is utilized in measuring the hydration state of subjects. There are certain equations which have been established to connect the resistance of TBW, ECW and ICW with the electric current considering the sex, age and the weight of subjects. On the other hand, water volumes of these tissues are used to calculate the resistance obtained (Baron et al., 2014). It has been shown that it is difficult for low frequency current to cross the cell membranes, thus a frequency of 5HZ estimates the water volume of the ECV, while higher (200HZ) frequency measures the water content of TBW (Shanholtzer& Patterson, 2003).

Bioelectrical impedance analysis has many methods: the single-frequency BIA (FS-BIA), the multiple-frequency BIA (MF-BIA), the bioelectrical spectroscopy (BIS), the segmented BIA, and the bioelectrical impedance vector analysis (Baron et al., 2014). The BIA has the advantage of providing rapid result, it is inexpensive, and can easily be carried out. Its disadvantages include: the existence of different types of BIA which leads to appropriable inter-BIA variation. Kyle, Bosaeus and De Lorenzo (2004) stated that the equation to be chosen for a study must be relevant to the population considering the ethnic group, age, abnormality in body shape or fat distribution (Baron et al., 2014). A study by Cox-Reijven and Soeters (2000) found that BIS lacked sensitivity in an overweight population. Variations in BIA measures may result from changes in electrode

position (Sinning& Morgan, 1993), changes in skin and ambient temperatures. This shows that there is need for the development of an improved method that could cancel these variations. Furthermore, BIA is likely to be impractical for large population studies involving free-living conditions particularly children (Mazariegos, Pithan & Meyer, 1998) and it cannot be used to assess acute hydration changes.

Changes in body weight method: Changes in body weight have been identified as one of the simplest techniques of determining hydration status particularly among the athletics during physical exercises. According to Cheuvront, Kenefick and Charkoudian (2013) the TBW level is approximately 60% of the entire weight of the body. In addition, water is the only body component that can easily be lost at a fast rate. As such, it consists of an accurate technique that is capable of detecting the acute alterations in the weight of the body. Moreover, alterations in the weight of the body are usually employed in the evaluation of the severity of dehydration as the clinical symptoms of dehydration to determine the extent of dehydration and the individual tolerance. This method has the advantage of utilizing all fluids (extracellular and intracellular), it is easy to perform with less time duration, requires no special skill, inexpensive, quick and has no adverse effect on the subjects.

Nevertheless, because the method has significant inter-individual variations of 26·6% (Cheuvront et al., 2010) arising from the changes in some content of the body including fat composition, muscle mass, gender and age, an individual specific baseline data is important and this is not easily accessible. Furthermore, modifications in the composition of the body without changes in the hydration state would render these parameters unimportant in researches requiring long period of time as well as those where the subjects are in free-living conditions in which physiological function differs from that of physical exercises. This makes the parameter mostly relevant at a given time period, that is, in acute experimental settings after sport activity or intense exercise.

Clinical signs and symptoms: Although these parameters may depict some alterations in hydration status investigations have observed that they are less sensitive with poor specificity (Arnaoutis, Kavouras & Kotsis, 2013; Shirreffs, Aragon-Vargas & Chamorro, 2005) differing from various age groups. Irrespective of these limitations, Thomas, Tariq, Makhdomm, Haddad and Moinuddin (2003) stated that physicians frequently used them to diagnose dehydration without confirming their diagnoses by haematological tests. While clinical methods may not accurately be used for the assessment of hydration state, they may serve as important tools in suggesting the perturbation in electrolytes and water and in detecting mild dehydration. The major disadvantage associated with the use of signs and symptoms is that majority of them are based on the personal feelings rather than facts which mostly depends on the reports from patients. Signs and symptoms as well lack normal values from which they can be compared. Some signs and symptoms may be common to other disease and/or normal physiological conditions.

In normal healthy individuals, thirst can reflect the need for rehydration, but it may be compromised in the elderly, young children and in the elderly with physical and/or cognitive impairment who may not feel the sensation to drink when dehydrated (Bak et al., 2017). Studies that assessed the efficacy of several signs and symptoms in detecting hydration state found that dry mucosa (xerostomia) including dry tongue, (Vivanti, Harvey, Ash and Battistutta, 2008; Vivanti, Harvey & Ash, 2010) tongue furrows (Vivanti et al., 2008; Cross et al., 1992); and dry oral mucosa (Vivanti et al., 2008; Cross et al., 1992; Chassagne, Druesne, Capet, Ménard & Bercoff, 2006) might be effective in evaluating hydration status. However, these signs and symptoms can also occur in certain disease conditions such as Alzheimer's disease, which is associated with dry oral mucosa (Longmore, 2007); some medications such as chemotherapy or antidepressants are also known to have a similar effect (Cross et al., 1992).

Some studies have reported skin turgor or elasticity as a sign for dehydration, while most have found some limitations with its use in the assessment of hydration status in the older adult population. According to Longmore, (2007) skin turgor assessment involves the pulling of the skin to check the time it takes to return to its normal position and if it takes more than 2 seconds, the individual would be considered to be dehydrated. Other signs frequently found in literatures are sunken eyes (Mentes, Wakefield & Culp, 2006; Cross et al., 1992; Cheuvront & Sawka, 2005) tachycardia (Vivantiet al., 2008; Crosset al., 1992; Chassagne et al., 2006), hypotension or postural hypotension (Chassagne et al., 2006), speech difficulty (Crosset al., 1992) muscle weakness and increased capillary refill (Crosset al., 1992). These signs and symptoms may not assess hydration status reliably.

Fluid intake and fluid balance charts method: These are used to capture fact on the fluid consumptions and outputs of mostly patients whose fluid balance may be threatened by illness. They are used to identify patients having either positive or negative fluid balance. They are often needed in critically ill (ICU) patients because fluid balance may be a problem in those patients. Apart from this group of patients, other patients' fluid balance may need to be considered and monitored. Contrary to this, studies have found that health professional do not consider it necessary or even when they do, may not correctly fill the charts (Mentes et al., 2006; Callum et al., 1999). Watkins et al. (1997) found that some patients do not have fluid chart balances because health workers considered it not important. On the hand, fluid balance chart was not regarded as routine care plans (Stewart, 2009). Moreover, the fluid balance charts are not reliable in detecting the amount of urine produced in incontinent subjects because urine samples may not be measurable. Similarly, problem may also arise with patients who can move on their own and will not report excreted urine to the health worker thereby leading to underestimation of the fluid output.

According to Bak et al. (2017) fluid chart balances are known to have many limitations such as (1) it is time consuming; (2) there is need for enough commitment from both the subjects and the staff which require adequate training; (3) some health facilities may not have the needed equipments to support appropriate fluid date; (4) fluid balance chart considers only urine and gastrointestinal fluid output but does not consider fluid loss from the lungs and sweat. These factors may underestimate fluid outputs. (5) Fluid intakes may not be measured precisely following the involvement of many people including the subjects. This may be compounded by the fact that the health worker may not identify volumes of standard cups.

Evidently, study by Armstrong-Esther, Browne and Sander (1996) found thatnurses were unable to identify the accurate volumes of standard cup or glass. In another study, Jimoh, Bunn and Hooper (2015) reported that there was no association between the observed and documented fluid consumptions of residents living in care homes and suggested that they should fill drink diaries by themselves. Armstrong-Esther et al. (1996) similarly found that staff believed that fluid balance charts in not relevant in the assessment of hydration status and as such would fill or complete them inappropriately.

Despite the fact that fluid balance chart could be utilized in the assessment of hydration status, care should be taken to avoid or reduce some of its limitations. Callum et al. (2013) and Watkins et al. (1997) suggested that fluid balance charts should be frequently reviewed to make them accurate for detecting dehydrated patients or those at risk of developing hypohydraton, which clinicians have neglected because it is time consuming. Owing to these factors, fluid charts balance may not be suitable for cross sectional studies involving large population size.

Urinary indices: According to Jequier and Constant (2010) the kidney primarily regulates water loss during an increase of plasma osmolality. Thus, urine indices appear to measure hydration status better than other indices. Basically, there are three urinary markers and they are urine osmolality, urine specific gravity and urine colour. They are often used for the assessment of the urine concentration.

Urine osmolality: Baron et al. (2014) defined urine osmolality as the amount of osmotic solute contained of the urine. Its measurement like plasma osmolality makes use of either freezing-point or vapour pressure-depression osmometer and it is determined by the level of solute and the volume of water. These solutes include sodium, potassium and urea. The amount of these solutes depends on the dietary intakes and physiological conditions. Healthy dehydrated individuals produce little quantity of urine that is highly concentrated with increased urine osmolality while individuals with high fluid intake produce large volume of urine leading to low urine osmolality. Urine osmolality therefore reflect the effectiveness of the kidney to maintain a state of equilibrium in responds to the differences in the water composition of the body.

Its values are between 50 mOsm/kg and 1400mOsm/kg (Baron et al., 2014). It has the advantages of not being expensive and invasive; it is fast to obtain result, requires medium technical expertise and can be applied in large population studies living in free conditions. Its sensitivity (91%) can be compared with that of plasma osmolality (90%) and it can be used to identify small alteration in hydration status. Evidences from many previous studies showed that urinary osmolality rises with increase in dehydration (Armstrong, Soto & Hacker, 1998; Melin, Jimenez & Savourey, 1997; Shirreffs, Watson & Maughan, 2007; Kovacs, Senden & Brouns, 1999).

However, with this method, it is difficult to define a reference value for normal hydration and/or hypohydration. This is a disadvantage that has made it impossible to reach a consensus concerning

a reference value for dehydrated (Armstrong, Pumerantz & Fiala, 2010) thereby creating a variation from one country to another. Reports by the Panel on Dietetic Products Nutrition, and Allergies (NDA) (2010) and Manz et al. (2003) show that a relevant cut-off for urine osmolality may be set at values above 800mOsm/kg and could define the limit for euhydration and mild dehydration states. But this cut-off may not be applicable to the general population because of difference in dietary habits existing in various populations.

Urine specific gravity method: This evaluates the density of the urine and it can be referred to as the weight of urine in comparison to the same volume of distilled water. Baron et al. (2014) noted that the specific gravity of plain water is 1.00 while that of normal urine sample has a range of 1.013 to 1.029. The refractometer is a special instrument used for measuring urine specific gravity and it provides immediate result without technical expertise. Study by Armstrong et al., (1994) showed large correlation between urine osmolality and urine specific gravity suggesting that both parameters can measure hydration status consistently. Single test strip may also be utilized for the assessment of hydration status. It has major advantage of providing patients (especially the diabetics and those with kidney diseases) the opportunity of using it by themselves.

A study by Siegrist, Hess and Montandon (1993) demonstrated that test strips result correlated with the refractometry method. One primary disadvantage of urine specific gravity measurement is that it is affected by large molecule like glucose, protein and urea leading to wrong interpretation of increase in urine concentration. This scenario is as well seen in urine osmolality where the presence of glucose and urea induces an osmotic effect. Nevertheless, urine specific gravity has its strength in the fact that it has an equivalent specificity of 91% and sensitivity of 89% as do the urine osmolality measurements. It also has a low inter-individual variation

compared with urine osmolality and therefore suitable for the assessment of hydration status in studies with large sample sizes (Baron et al., 2014).

Urine colour: Urine colour is another marker frequently used for hydration status assessment. Urine colour chart developed to assess urine concentration has a standardized colour scale ranging from 1 (pale yellow, corresponding to diluted urine) to 8 (dark brown, corresponding to concentrated urine) (Baron et al., 2014). Cleary, Hetzler and Wasson (2012) reported that its cut-off value for defining euhydration and dehydration is 4 units. Urine colour method advantages include low cost, noninvasive, no special skill, provides urgent result with best specificity (97%). In all these techniques that employ urinary markers, urine colour has negligible analytical variations (Cheuvront et al., 2010).

Armstrong et al. (1998) observed a linear relationship between urine colour, specific gravity and osmolality. This implies that every one of these markers is good for the determination of hydration status. However, but urine colour chart measurement has a major disadvantage of being insensitive (Cheuvront et al., 2010) and may be influenced by factors relating to diet, disease and drugs (Simerville, Maxted & Pahira, 2005) as a result of substantial differences in intra-individual (30·9%) and inter-individual (47·4%,) (Cheuvront et al., 2010). Although urine colour is less likely to be sensitive compared to other markers, it may be very much specific than urine osmolality or specific gravity in the assessment of hydration status.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area

The study was conducted in Enugu, Kaduna, and Oyo States of Nigeria. Nigeria lies on the west coast of Africa between latitudes 4º16' and 13º53' north and longitudes 2º40' and 14º41' east. It occupies about 923,768km^{2}of land extending from the Gulf of Guinea on the Atlantic coast in the south to the fringes of the Sahara Desert in the north. It has boundaries with the republics of Niger and Chad in the north, the Republic of Cameroon on the east, and the Republic of Benin on the west. According to Nigeria Demographic and Health Survey (2013) Nigeria has the largest number of people in Africa and it is the 14th largest populated country in terms of its land mass.

The population of Nigeria is estimated to be 198 million (National Population Commission (2018). The country comprises of 36 states with a Federal Capital Territory (Abuja). It is grouped into 6 geopolitical zones including North Central, North East, North West, South East, South South, and South West. These geopolitical zones are further classified into 774 local government areas (LGAs). The universities used for this study were University of Ibadan (UI) established in 1948, University of Nigeria, Nsukka (UNN) established in 1960 and Ahmadu Bello University (ABU) Zaria, established in 1962.

3.2 Study design

This study adopted a cross sectional design. Cross-sectional study design was conducted to investigate an outcome of interest at one point or snapshot of the proportion of individuals in the population that are exposed to the effect of interest at one point in time and does not indicate the sequence of events occurring before, after or during the onset of the outcome (Levin, 2006).

3.3 Study population

The study population included all healthy university undergraduates between the ages of 16-24 years in three Federal universities in Nigeria.

3.4 Sample size determination

The sample size was derived from 15% of the total number of students from each university and the WHO (2013) guideline for calculation of sample size in a survey.

$$n = \frac{\frac{z^2 \times p\,(1-p)\,z^2}{e^2}}{1+\left[\frac{z^2 \times p\,(1-p)}{e^2 N}\right]}$$

Where n = sample size

z = level of confidence (1.96)

p = baseline levels of the indicators (0.5 or 50%)

e = margin of error (0.05 or 5%)

N = population size

Table 3.1: Number of required faculties and department

Name of university	Number of faculties	Number of departments	Number of faculties selected	Number of departments selected
ABU	12	58	4	15
UI	15	68	5	17
UNN	15	78	5	17
Total	42	204	14	49

Step 1: determination of the sample size from the faculties

Ahmadu Bello University, Zaria has a total number of 15,250 undergraduates

Fifteen percent (15%) of 15,250 = 15/100 X 15,250/1 = 0.15 X 15, 250 = 2287.5

Substituting into the above equations

1st equation= $\mathbf{1.96\ X\ 1.96\ X\ 0.5}\ X\ \mathbf{0.5}$/0.05 x 0.05

= $3.8416\ X\ 0.5\ X 0.5/0.0025$

= $0.9604/0.0025$ = 384.16

2nd equation = $1+ \left[\frac{1.96 \text{ x } 1.96 \times 0.5 \text{ x } 0.5}{0.05 \text{ x } 0.05 \text{ x } 2287.5}\right]$

= 1.9604/5.71875 = 0.3428

We have = 384.16/0.3428 = 1121

A total number of 1121 students were used from ABU Zaria

University of Ibadan has a total number of 15, 773 undergraduates

15% of 15773 = 2366

Substituting into the above equations

1st equation = 1.96X1.96 X 0.5 x 0.5/ 0.05 X0.05

= 3.8416 X 0.25/0.0025

= 0.9604/0.0025 = 384.16

2nd equation = 1 +(1.96 X1.96 X0.5 X0.5)/ 0.05 X 0.05 X 2366 = 5.915

= 1.9604/ = 0.3314

= 384.16/0.3314 = 1159

A total number of 1159 students were used from University of Ibadan

University of Nigeria, Nsukka has a total number of 22,047 undergraduates

15% of 22,047 =3307

Substituting into the above equations

1st equation = 1.96X1.96 X 0.5 x 0.5/0.05 X0.05

= 3.8416 X 0.25/0.0025

= 0.9604/0.0025 = 384.16

2nd equation = 1 +(1.96 X1.96 X0.5 X0.5)/ 0.05 X 0.05 X 3307 = 1.9604/8.2675

= 0.2371 = 384.16/0.2371 = 1620

A total number of 1620 students were used from UNN

Total sample size = 1121+1159+ 1620 = 3900

Therefore 3900 students from the three universities were used for the study but a total of 3248 was used for statistical analysis because that is the number of respondents that filled and completed the questionnaires correctly. This value gave response rates of 81% for ABU, 98% for UI and 74% for UNN.

The sample size calculation resulted to the following sample distribution by faculty:

Table 3.2: Number of faculties and respondents

Institution	Faculty	Number of respondents
ABU		
	Faculty of Education	245
	Faculty of Engineering	285
	Faculty of Life Science	230
	Business School	361
Total		**1121**
UI		
	Faculty of Agriculture	104
	Faculty of Art	390
	Faculty of Technology	295
	Faculty of Basic Sciences	283
	Faculty of Public Health	87
Total		**1159**
UNN		
	Faculty of Agriculture	250
	Faculty of Biological Science	470
	Faculty of Engineering	400
	Faculty of Social Science	335
	Faculty of Physical Sciences	165
Total		**1620**

Table 3.3: Number of departments selected from each faculty

Faculty	Number of respondents from each faculty	Department	Number of respondents from each department
ABU			
Faculty of Education	245	Educational Foundation and Curriculum	55
		Educational Psychology and counseling	41
		Library and Information Science	40
		Science Education	50
		Educational Foundation and Curriculum	59
Faculty of Engineering	285	Chemical engineering	72
		Electrical engineering	90
		Civil engineering	80
		Metallurgical engineering	43
Faculty of Life Science	230	Biochemistry	80
		Biological Sciences	69
		Microbiology	81
Business School	361	Accounting	84
		Business administration	125
		Public administration	152

Table 3.3: Number of departments selected from each faculty cont'd

Faculty	Number of respondents from each faculty	Department	Number of respondents from each department
UI			
Faculty of Agriculture	54	Fisheries and wildlife management	30
		Forestry resources management	24
Faculty of Art	390	Archaeology	90
		Archaeology Combined	50
		Anthropology	75
		Religious Studies	83
		Communication and Language Arts	92
Faculty of Basic Medical Sciences	295	Anatomy	74
		Chemical Pathology	72
		Medical Microbiology and Parasitology	83
		Pathology	66
Faculty of Technology	333	Industrial Production Engineering	83
		Petroleum Engineering	80
		Food Technology	98
		Mechanical Engineering	72
Faculty of Public Health	87	Human Nutrition and Dietetics	57
		Health Policy and Management	30

Table 3.3: Number of departments selected from each faculty cont'd

Faculty	Number of respondents from each faculty	Department	Number of respondents from each department
UNN			
Faculty of Agriculture	250	Agricultural Economics	30
		Animal Science	32
		Food science and Technology	63
		Nutrition and Dietetics	125
Faculty of Biological Science	470	Microbiology	140
		Biochemistry	177
		Combined Biological Sciences	153
Faculty of Engineering	400	Civil Engineering	135
		Electronics engineering	109
		Mechanical Engineering	156
Faculty of Social Science	335	Public Administration & Local Government	170
		Economics	60
		Political Science	55
		Sociology & Anthropology	50
Faculty of Physical Sciences	165	Computer Science	85
		Physics and astronomy	80

3.5 Sampling techniques

The study adopted multi-stage and stratified sampling techniques. The multi-stage sampling involved five stages. In the 1st stage, 3 out of 5 first generation universities were purposively selected, namely ABU, UI and UNN. In the 2nd stage, (14) faculties were selected from the three universities suing random sampling by balloting without replacement. In the 3rdstage, a total of 48 departments were proportionately selected using random sampling by balloting without replacement. In the 4rd stage, respondents were proportionately stratified sampling according to their year of study (100-600) levels. In the 5th stage, systematic random sampling (1 out of every 3 students) was used to select a total of 3900 respondents.

3.6 Sub-sample

Purposive sampling was used to select the sub-sample respondents consisting of 5% of the calculated sample size (3900) for the fluid intake and hydration status assessments.

= 5/100 x 3900

= 195 respondents

Using proportional sampling

1121/3900:1159/3900:1620/3900

1/3900 of 195 = 0.05

For ABU = 1121 x 0.05

= 56 respondents

UI= 1159 x 0.05

= 58 respondents

UNN = 1620 x 0.05

= 81

Total = 56+58+81 = 195 respondents. However, 162 students were used for the statistical analysis in this study due to human errors in filling questionnaires.

3.7 Inclusion and exclusion criteria

Non pregnant and lactating women without any health condition like fever, diarrhea vomiting, kidney diseases or medical complications of chronic diseases such as edema or undergoing medical treatment or therapy related to management of body weight, not undergoing vigorous physical activity and male and female within 16-24 years in both halls of residence and off campus were eligible. Pregnant, lactating and sick students (having any disease that is capable of distorting water balance like urinary tract infection, kidney disease, and diabetes mellitus) or on medication including supplements, under or over aged, poor completion of questionnaire and refusal to give consent were excluded from the study.

3.8 Recruitment and training of research assistants

Nine research assistants (3 from each university) were recruited and trained on administration and collection of the questionnaire and Liq.In[7] record, and how to use of refractometer to elicit information for hydration status.

3.9 Ethical approval

Ethical approval for the use of human subjects in research was obtained (Registration Number: NHREC/TR/08/10/2013A) from the Federal Ministry of Health, Abuja.

3.10 Informed consent

A letter of introduction from the Head of Department of Nutrition and Dietetics of the University of Nigeria, Nsukka, was obtained by the researcher and used to seek approval from the various university authorities to carry out the research in their institutions. The objectives, detailed procedures as well as the benefits of the study were explained to the respondents and their informed consent to participant in the study was obtained by filling and signing the consent forms. Participants were allowed to withdraw or refuse to take part in the study without prejudice.

3.11 Method of data collection

Data were collected using questionnaire, a seven-day fluid specific record, urine specific gravity and urine colour.

3.12 Questionnaire

A structured questionnaire validated by five lecturers in the Department of Nutrition and Dietetics, University of Nigeria, Nsukka was used to collect information. It was pretested on the students of College of Education, Nsukka who did not participate in the study to affirm its reliability and the appropriate reliability index was calculated from Cronbach alpha formula. Reliability score of 0.8 was accepted. The questionnaire provided information on socio-demographic characteristics of the students; frequency and pattern of consumption of water and beverages and factors associated with the consumption fluid among the students.

3.13 Assessment of fluid intake with a seven-day fluid specific record

The English version of self-administered 7-day fluid-specific record (Liq.In^7 record) adopted from Laksmi (2018) was used to record the usual fluid intakes. The 7-day fluid-specific record a tool that estimates fluid intake over 7 consecutive days mostly used in cross-sectional surveys (Ferreira-Pego et al., 2014; Iglesia-Altaba et al., 2015) was adopted in this study. The Liq.In^7 record was distributed and explained to the study participants during the questionnaire distribution. The total daily consumption of fluid for the assessment of optimal hydration was set at 2.60L while that for assessing hypohydration was 2.4L and less. These represent the mean values of the recommendations of European Food Safety Authority (2010), Institute of Medicine (2005) and WHO (2003).

Photograph of standard bottles (i.e., 20, 30, 33, 35mls) was provided to reduce the ambiguities that may arise from wrong judgments of actual fluid intake volumes that are likely to be observed. Participants who reported a mean total fluid consumption that is below 0.4 L/day or higher than 6L/day and not completing the 7 days fluid record was excluded from the study. The research assistants visited participants assigned to them to administer and make sure that they understood what they did. Those who did not complete the 7-day record were excluded from the study and replaced with other interested students who may not be initially selected for the study to make up for the required number.

Respondents were urged to record every drinking occasion each day including the type of fluid, volume of bottle or can containing each type of fluid they took, the specific amount of fluid they drank from the entire volume. Water compositions of foods consumed were not included. Total fluid intake (TFI) was defined as the sum of the volumes of water and beverage categories. A drinking occasion consists of any kind of fluid taken at any time during the day.

The average volume per drinking occasion was estimated by dividing TFI by the number of drinking frequency (Bardosono et al., 2015). The percentage of the fluid intake from water and beverages was calculated using Briawan (2011) formula. This is based on the report that solid foods contribute 20% to the total fluid intake (Bardosono et al., 2015), therefore 80% was used instead of 100% in calculating the percentage of water or beverage to fluid intake of the students.

$$\% \text{ of water from fluid} = \frac{\text{proportion of water to fluid intake}}{\text{TFI}} \text{ X } \frac{80\%}{1}$$

For the percentage of fluid intake from beverages, it was = $\frac{\text{proportion of all fluid intake from a beverages}}{\text{TFI}} \text{ X } \frac{80\%}{1}$

Specific beverage was calculated thus:

% of water intake to fluid was = $\frac{\text{proportion of fluid intake from a specific beverage}}{\text{Total fluid intake from all the beverage}} X \frac{80\%}{1}$

The observed 7-day mean TFI was compared with the reference intake of EFSA (2010), Institute of Medicine (2005) and WHO (2003).

For the purpose of this study beverages were grouped into thirteen classes namely: (a) milk and milk products (all drinkable yoghurt, faradenunu and others), (b) Soybean milk, (c) hot beverages (including tea, coffee, milo, bournvita, green tea, ovaltine, holics), (d) 100% fruit and vegetable juices, (e) Soft drink (coke, fanta, sprite and others), (f) fruit drinks, (g) energy and sport drinks, (h) Malt drink, (i) flavoured water, (j) Alcoholic beverages (wines, beer and spirit), (k) zobo drink, (l) kunu and (m) other beverages taken by respondents but not included in the above list. This was a modification from the study of Nissensohn et al. (2016).

3.14 Urine specific gravity (USG): This was measured with a portable handheld urine refractometer. The surface of the refractometer was cleaned with a clean tissue paper and distilled water. Two mills (2ml) of distilled water were dropped onto the reading surface and the lid was closed, the researcher and the assistants looked through the piece to ensure that the line between the blue and the white sections lie at 1.000 SpG point. If it does not, the calibration dial was adjusted to bring the dividing line to 1.000 point. This ensures that the refractometer was accurate and that the readings were reliable.

3.15 Urine sample collection

Twentymills (20mls) of urine samples were collected from each sub-sample with a 20ml capacity sterilized wide mouthed bottle which was clearly labeled with a unique identification code of the subject. The sample bottles were collected and placed in a closed polystyrene box away from direct sunlight. Samples were obtained between 6:00AM and 8:00AM of the day. That is first morning urine. Students were instructed to pass a little urine before filling the bottle and then

replace the lid. The urine samples were gently inverted (to make sure that it was well mixed) and one or two drops of the urine were placed onto the refractometer using a clean syringe and the value of the specific gravity was read and recorded.

Each measurement was repeated twice, but if the measurements differed by as much as 0.001g/ml, a third measurement was taken and averages of the two closet measurements were used (Gordon et al., 2015). The refractometer was cleaned after each test. Subjects started the assessment of hydration status on different days of the week in order to achieve a reasonable distribution of starting days over the week, while going about their normal daily routine. The mean values were classified as euhydrated, hyperhydrated, hypohydrated/dehydrated according to Armstrong et al. (2010) classification.

3.16Urine colour test

The same urine samples collected was used to evaluate the urine colour and marched with the colour on the urine colour chart which is divided into 8 portions (Fig 1). Urine was classified as clear, amber, light yellow and deep yellow with 1to 3 corresponding to euhydration and 4 to 8 corresponding to dehydration.

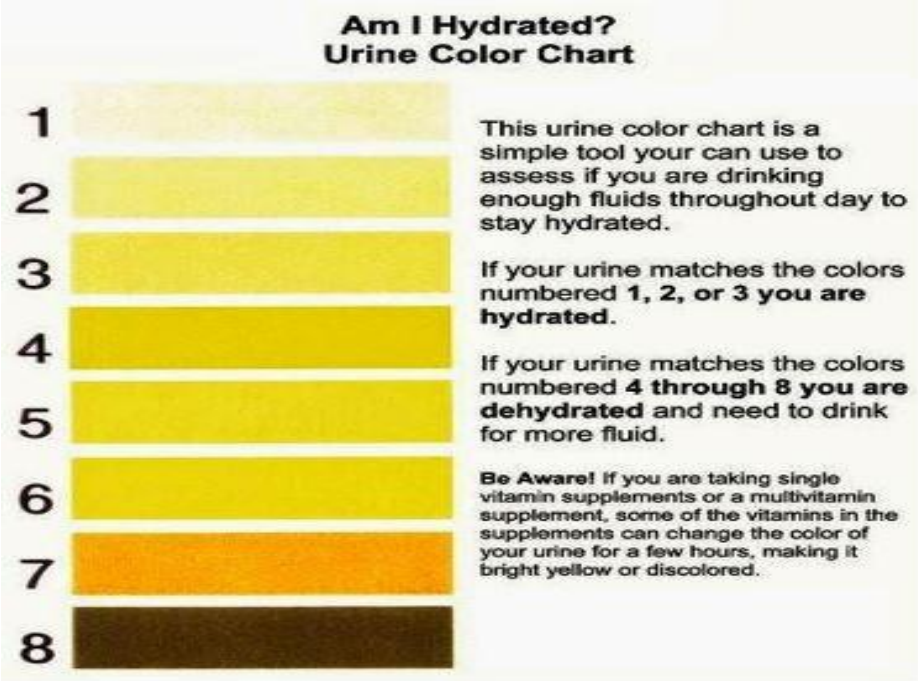

Figure 2: Armstrong's Colour chart

Source: Armstrong 1994

3.17 Statistical analysis

The data from the questionnaire was analyzed using descriptive and inferential statistics with the IBM SPSS Statistics software version 20. Chi-square, Pearson correlation and ANOVA tests were used to determine the relationship between water and beverage consumption, fluid intake and hydration status. The result was expressed as frequencies, percentages, means and standard deviations. The significance level was accepted at $p < 0.05$

CHAPTER FOUR

RESULTS

Table 4.1a shows the sex, age, region and place of residence of the respondents. A total of 3,248 respondents aged 16-24 years participated in this study. More than half (56.2%) of the respondents were males, and 65.9%were 20-24 years old. Less than half (36.8%) of the respondents were from the eastern part of Nigeria followed by 35.1% from the West and 28.1% from the North. More (57.1%) of the respondents lived in the hostel while 42.9% lived off-campus at the time of the study.

Table 4.1a: Sex, age and place of residence of the respondents

Variable	ABU		UI		UNN		Total	
	F	%	F	%	F	%	F	%
Sex								
Male	534	58.5%	659	57.8%	631	52.8%	1824	56.2%
Female	379	41.5%	481	42.2%	564	47.2%	1424	43.8%
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2 = 8.735, df = 2, p =0.013							
Age (Years)								
16-19	302	33.1	470	41.2	334	27.9	1106	34.1
20-24	611	66.9	670	58.8	861	72.1	2142	65.9
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2 = 46.343, df = 2, p = 0.000							
Region								
Northern	913	100					913	28.1
Eastern					1195	100	1195	36.8
Western			1140	100			1140	35.1
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2= 6496.000, df =4, p = 0.000							
Place of residence								
Hostel	627	68.7	929	81.5	300	25.1	1856	57.1
Off-campus	286	31.3	211	18.5	895	74.9	1392	42.9
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2 = 826.411, df =2, p = 0.000							

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
X^2 = chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

Table 4.1b presents the marital status, educational level and monthly allowance of the respondents by institution. Most (95.1%) of the respondents were single. About 28% of the respondents were 100 level students, 26.4% were at 300 level and 23.8% were at 200 level. A good percentage (73.3 %) of the respondents had monthly allowance of less than ₦25, 000 while 5.9% had above ₦50, 000.

Table 4.1b: Marital status, educational level and monthly allowance of the respondents

Variable	ABU		UI		UNN		Total	
	F	%	F	%	F	%	F	%
Marital status								
Single	862	94.4	1088	95.4	1138	95.2	3088	95.1
Married	45	4.9	49	4.3	40	3.3	134	4.1
Divorced	1	0.1	1	0.1	12	1.0	14	0.4
Separated	2	0.2	2	0.2	4	0.3	8	0.2
Widowed	3	0.3	0	0.0	1	0.1	4	0.1
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2= 23.063, df =8, p = 0.003							
Educational level								
100	350	38.3	230	20.2	332	27.8	912	28.1
200	129	14.1	451	39.6	194	16.2	774	23.8
300	298	32.6	292	25.6	266	22.3	856	26.4
400	108	11.8	104	9.1	280	23.4	492	15.1
500	26	2.8	41	3.6	106	8.9	173	5.3
600	2	0.2	22	1.9	17	1.4	41	1.3
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2 = 409.840, df = 10, p = 0.000							
Monthly allowance								
Less than ₦25,000	755	82.7	670	58.8	951	79.6	2376	73.3
₦ 25,000- ₦ 50,000	115	12.6	375	32.9	191	16.0	681	21.0
Above ₦ 50,000	43	4.7	95	8.3	53	4.4	191	5.9
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2= 190.406, df =4, p = 0.000							

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
X^2= chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

Table 4.2a shows the source of drinking water, frequency and quantity of water taken each time. Less than half (34.2%) and (33.6%) of the respondents across the three universities drank tap and bottled water, respectively. More (40.6%) of the respondents in ABU preferred tap water followed by borehole (29.6%) and bottled water (23.0%). Greater percentages (40.4%) of respondents from UI took bottled water followed by tap (34.5%) and by borehole (16.5%) while more (35.5%) of those in UNN took bottled water followed by borehole (29.5%) and lastly tap (29.0%). Spring water was the least (1.8%) source of water for the respondents in the three institutions.

More than half (59.8%) and 55.9% of the respondents from UI and UNN took water 3-6 times daily while less than half (49.4%) of those from ABU did. Water was mostly taken 3-6 times daily by all the respondents; however, respondents from ABU were less likely to drink water 3-6 times compared with those in the other two universities. Less than thirty percent (28.0%) of respondents consumed water more than 6 times a day while very few (16.6%) drank water below 3 times a day across the institutions. Among the three universities, more (57.3%) of ABU, (44.7%) of the respondents in UI and 53.2% in UNN drank 600mls (1 sachet or $2\frac{1}{2}$ glasses) of water each time of drinking occasion. This was followed by those who took more than 1800mls (3 sachets or 7 cups) of water at each drinking occasion.

Table 4.2a: Source of drinking water, frequency and quantity of water taken each time

Variable	ABU		UI		UNN		Total	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Source of drinking water								
Rain water	25	2.7	46	4.0	36	3.0	107	3.3
River	23	2.5	34	3.0	13	1.1	70	2.2
Borehole	270	29.6	188	16.5	352	29.5	810	24.9
Spring	14	1.5	19	1.7	26	2.2	59	1.8
Tap	371	40.6	393	34.5	346	29.0	1110	34.2
Package bottled water	210	23.0	460	40.4	422	35.3	1092	33.6
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2 = 132.909, df = 10, p = 0.000							
How often do you drink water daily								
< 3 times	227	24.9	136	11.9	175	14.6	538	16.6
3-6 times	451	49.4	682	59.8	668	55.9	1801	55.4
>6 times	235	25.7	322	28.2	352	29.5	909	28.0
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2= 68.009, df = 4, p = 0.000							
How much water do you drink each time								
600mls (1 sachet)	523	57.3	510	44.7	636	53.2	1669	51.4
1200mls (2 sachets)	147	16.1	134	11.8	195	16.3	476	14.7
1800mls (3 sachets)	109	11.9	124	10.9	114	9.5	347	10.7
More than 1800mls (3 sachets and above)	134	14.7	372	32.6	250	20.9	756	23.3
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2= 104.446, df = 6 , p = 0.000							

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
X^2= chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

Pattern of water consumption of the respondents was presented in Table 4.2b. Regarding the time water is mostly consumed, more than two third (68.8%) of the respondents in ABU, 78.1%in UI and 77.2% in UNN took water at any time of the day. However, more respondents (18.0%) and (12.2%) from ABU and UNN, respectively took water in the afternoon than those (5.4%) in UI. On awakening majority (74.6%) of UI students drank water while 53.3% of those in ABU and 52.8% in UNN did not. Drinking water while eating food was a common practice in the three institutions as approximately (81%) of respondents in ABU, (87%) in UI and (78%) in UNN took water while eating. Nearly all the respondents (97.8%) in ABU, (95.0%) in UI and (98.8%) in UNN reported drinking water when thirsty and more (5.0%) of respondents in UI are likely to ignore the urge of thirst than those in ABU (2.2%) and UNN (1.2%).

Table 4.2b: Pattern of water consumption of the respondents

Variable	ABU		UI		UNN		Total	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Time water is consumed most								
Morning	100	11.0	171	15.0	102	8.5	373	11.5
Afternoon	164	18.0	61	5.4	146	12.2	371	11.4
Night	21	2.3	18	1.6	25	2.1	64	2.0
Any time of the day	628	68.8	890	78.1	922	77.2	2440	75.1
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2= 101.524, df = 6, p = 0.000							
Time water is consumed								
On awakening								
Yes	426	46.7	850	74.6	631	52.8	1907	58.7
No	487	53.3	290	25.4	564	47.2	1341	41.3
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2= 190.060, df =2, p = 0.000							
While eating food								
Yes	738	80.8	990	86.8	926	77.5	2654	81.7
No	175	19.2	150	13.2	269	22.5	594	18.3
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2=34.807, df =2, p = 0.000							
When thirsty								
Yes	893	97.8	1083	95.0	1181	98.8	3157	97.2
No	20	2.2	57	5.0	14	1.2	91	2.8
Total	**913**	**100**	**1140**	**100**	**1195**	**100**	**3248**	**100**
	X^2 = 33.143, df =, p = 0.000							

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
X^2 = chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

Table 4.3 presents the beverage consumption of the respondents by institutions. Almost all the respondents (95.3%) in ABU, (95.3%) in UI and (96.4%) in UNN took one form of beverage or the other. Only very few (4.7%), (4.7%) and (3.6%) in ABU, UI and UNN, respectively did not consume beverages at all.

Table 4.3: Beverage consumption of the respondents by institutions

Variable	ABU	UI	UNN	Total
	F (%)	**F (%)**	**F (%)**	**F (%)**
Yes	870(95.3)	1086 (95.3)	1152 (96.4)	3108 (95.7)
No	43 (4.7)	54 (4.7)	43 (3.6)	140 (4.3)
Total	**913 (100)**	**1140 (100)**	**1195 (100)**	**3248 (100)**
		x^2=2.325, df=2, p=0.313		

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
X^2 = chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

Figure 4.1 shows the frequency of cow milk and its products and soybean milk consumption of respondents by institutions. More students (31.7%) from UI drank cow milk and its products than those of them from ABU (16.4%) and UNN (11.6%) on daily basis. On the contrary, more (36.2%) of students from UNN and ABU (35.2%) took cow milk on weekly basis compared to those from UI (31.7%). More students (37.6%) and (57.8%) in ABU and (42.3%) and (55.2%) in UNN rarely took cow and soybean milk, respectively than (21.3%) and (33.2%) of those in UI who rarely drank them. Similarly, a greater percentage of participants in ABU (35.2%) and (36.2%) in UNN drank more cow milk and its products 1-3 times per week.

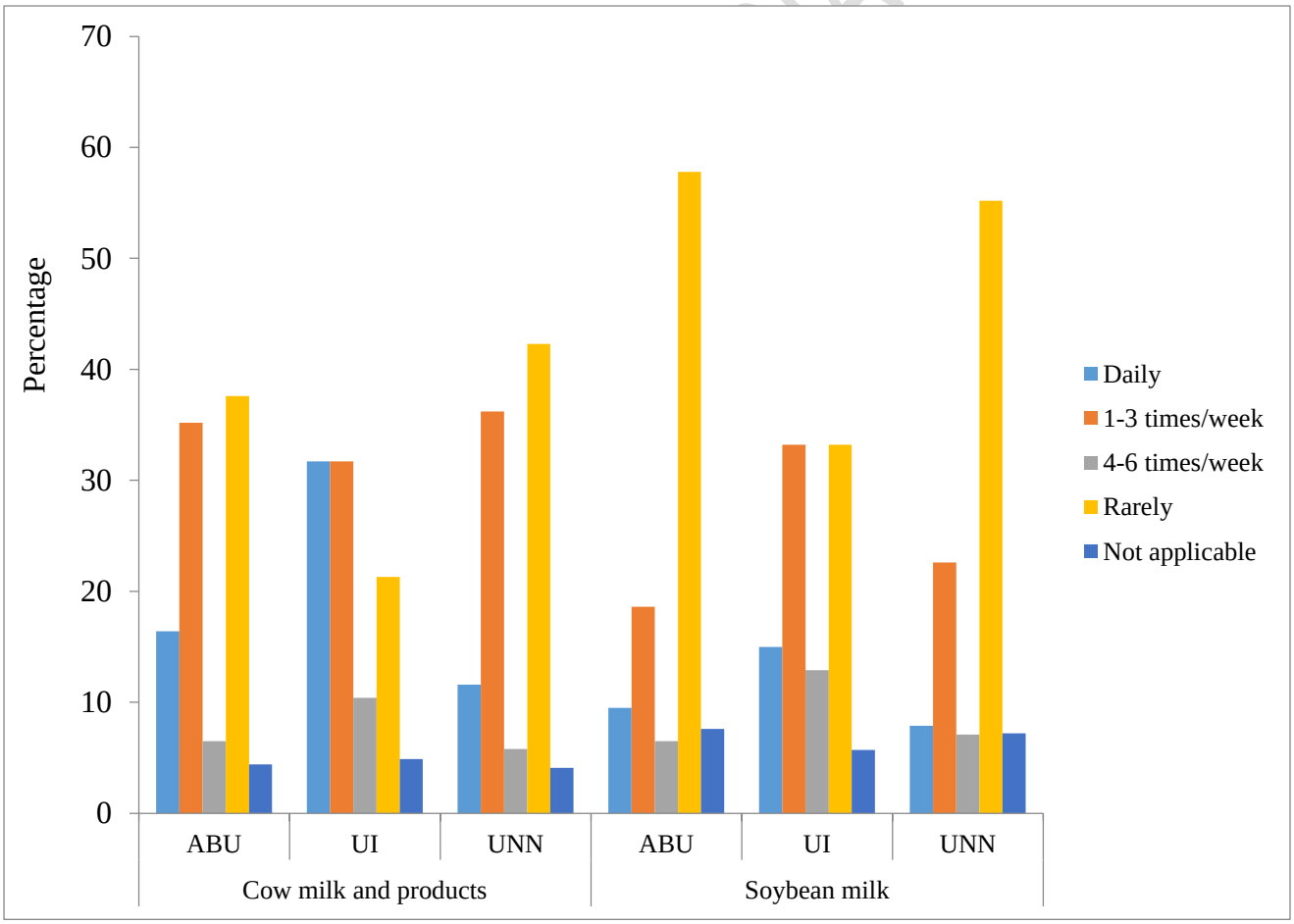

Figure 4.1: Frequency of cow milk and its products and soybean milk consumption of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.2 presents the frequency of hot beverages and 100% fruit juice consumption of the respondents. More (35.0%, 39.6% and 38.0%) of respondents in the three institutions drank hot beverages 1-3 times in a week. On daily basis, more (28.8%) of the respondents from ABU took hot beverages followed by UI (18.9%) and lastly by UNN students (14.2%).Few (12.8%), (17.3%) and (10.3%) respondents in ABU, UI and UNN, respectively took 100% fruit juice daily whereas more (43.2%) respondents from UNN, (41.0%) in ABU and (23.0%) in UI rarely took 100% fruit juice.

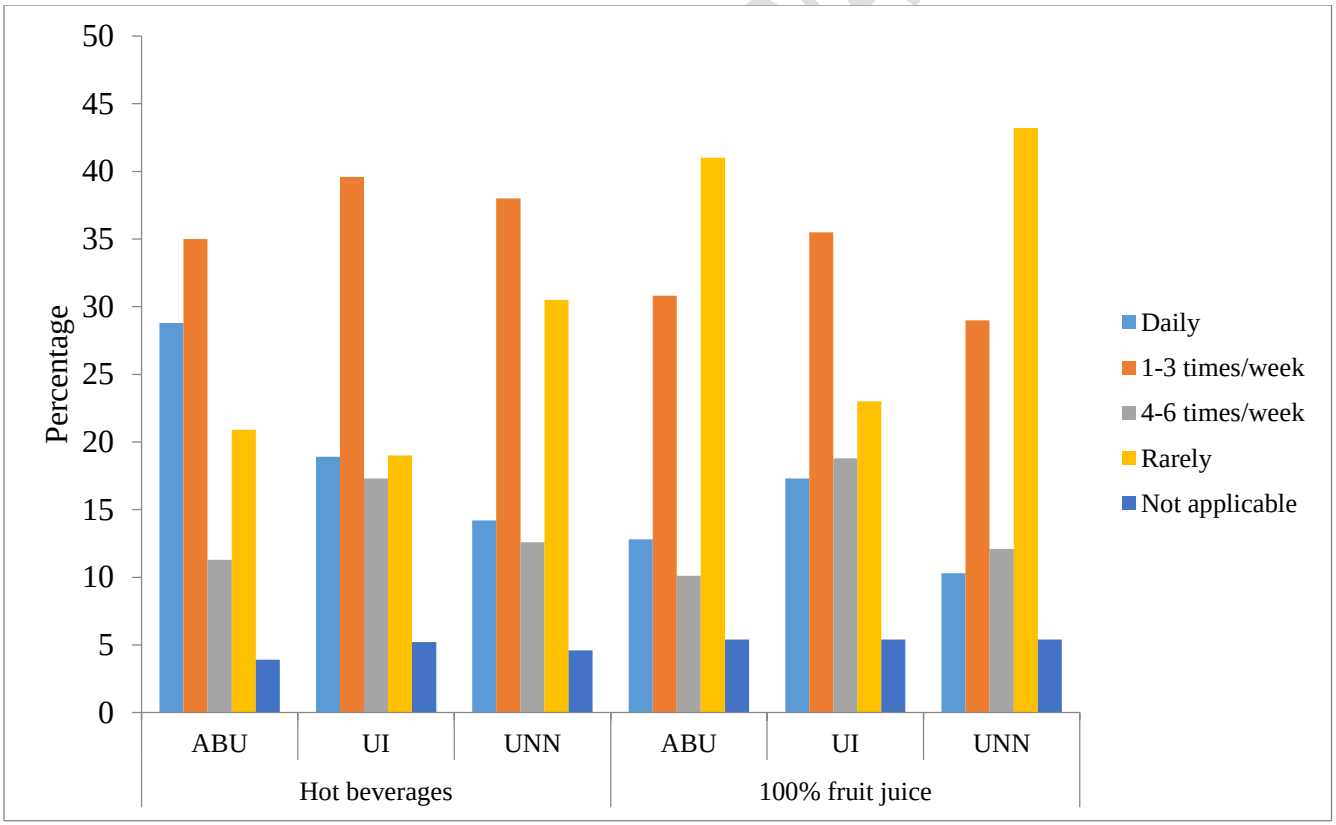

Figure 4.2: Frequency of consumption of hot beverages and 100% fruit juice of respondents by institution

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.3 shows the frequency of consumption ofsoft and fruit drinks of the respondents by institutions. More (42.8%) of the respondents in UI consumed soft drink 1-3 times per week followed by 40.6% of UNN students and lastly by 35.2% of ABU students. Less than forty percent (38.0%) of students in UI, 31.1% of those UNN took fruit drink 1-3 times while only 27.3% of those in ABU did. Similarly, more (30.9% for ABU and 24.1% for UNN) drank soft drinks rarely and (45.1% for ABU and 44.0% for UNN) consumed fruit drinks rarely. On the contrary, respondents in UI took more (18.6%) of soft and (17.7%) of fruit drinks 4-6 times weekly than those in ABU and UNN.

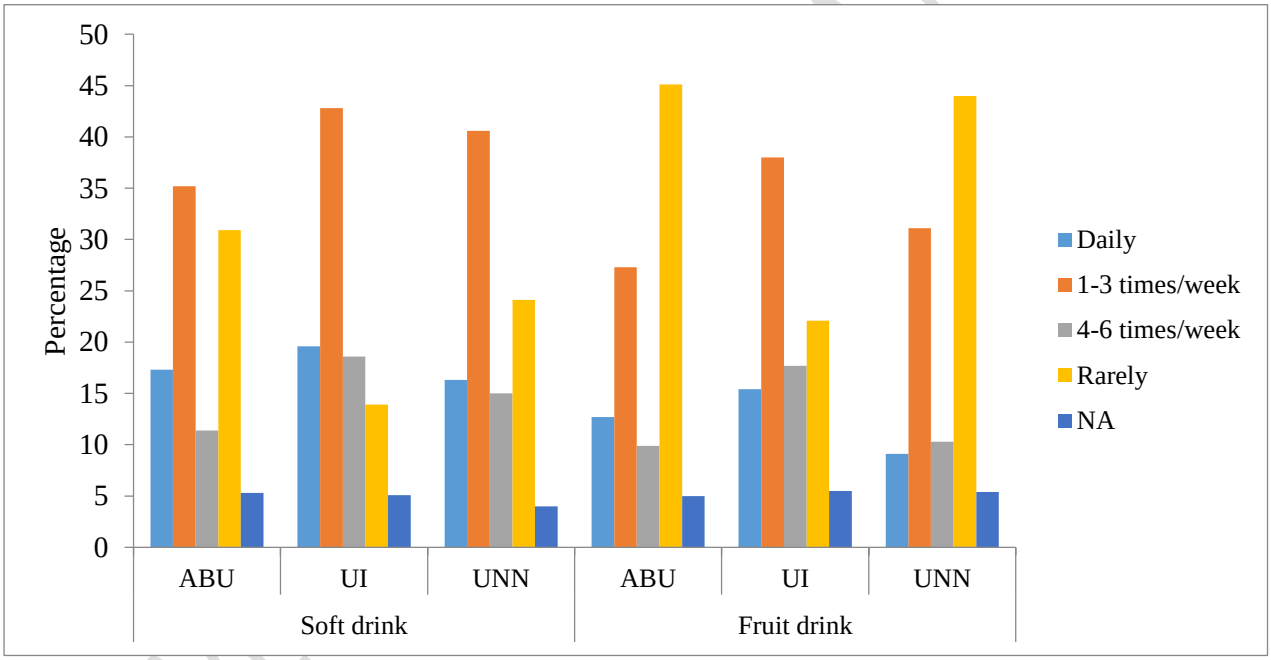

Figure 4.3: Frequency of consumption of soft and fruit drinks of respondents by institutions.

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka, NA = Not applicable

Figure 4.4 describes the frequency of consumption of energy and sport and malt drinks consumption of respondents.A significant percentage (59.6%) of the participants in ABU and 62.7% in UNN consumed energy and sport drinks rarely as against 32.8% of those in UI. Based on 1-3 times intake of energy and sport drinks, more than one quarter (31.3%) of students in UI took almost double (16.8%) of what the participants in ABU and above half (18.2%) of the quantity taken by respondents in UNN. Malt drink was commonly taken 1-3 times every week by 30.6% of respondents in UI, 25.4% of those in ABU and 18.2% of those in UNN.

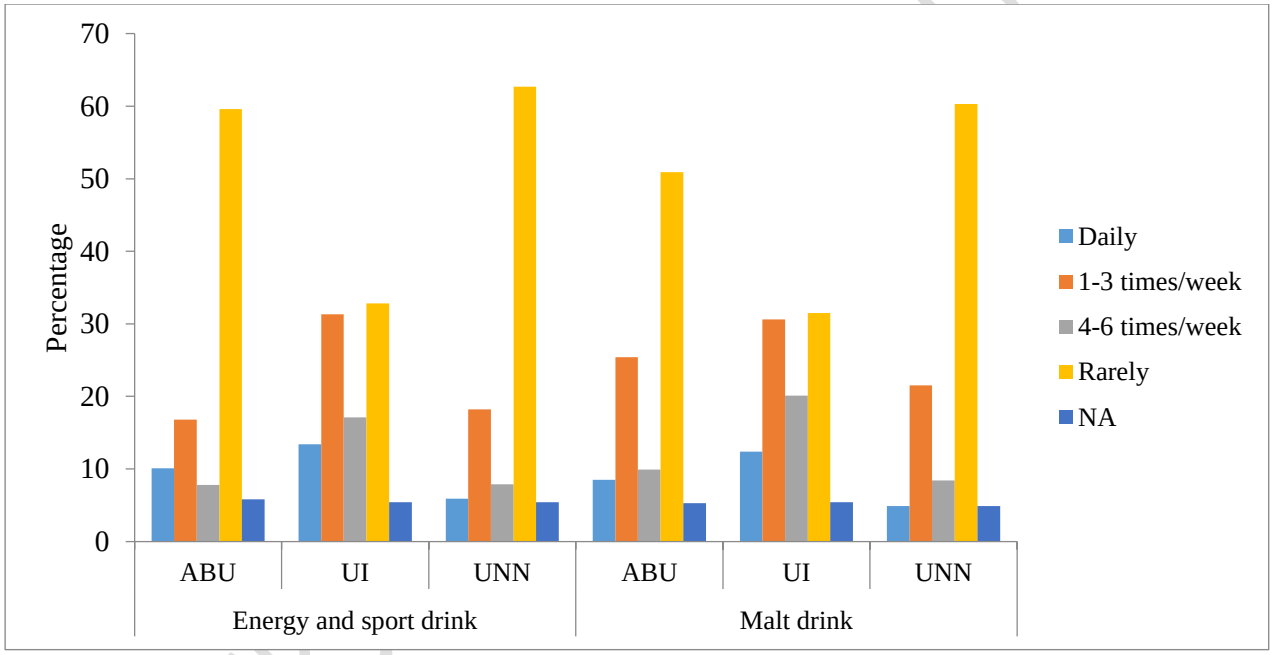

Figure 4.4: Frequency of consumption of energy and sport and malt drinks of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka, NA = Not applicable

Figure 4.5 shows thefrequency of consumption of flavoured water and alcoholic beverages of respondents by institution. Many (70.7%) and (69.7%) of UNN respondents rarely drank flavoured water and alcoholic beverages, respectively. More than sixty percent (60.9%) and (62.3%) of those in ABU equally consumed these beverages rarely. On weekly basis, more students (24.9%) and (24.3%) in UI took flavoured water and alcoholic beverages 1-3 times while 17.0% and 14.9% drank them 4-6 times more than participants (7.2%) in ABU and (4.25) in UNN. Similarly, UI students took almost twice (14.6%) of flavoured water compared with those in ABU (8.7%) and UNN (6.6%) per day and more than two times (11.6%) of alcoholic beverages consumption of respondents in ABU (4.9%) and four times (2.7%) than respondents in UNN.

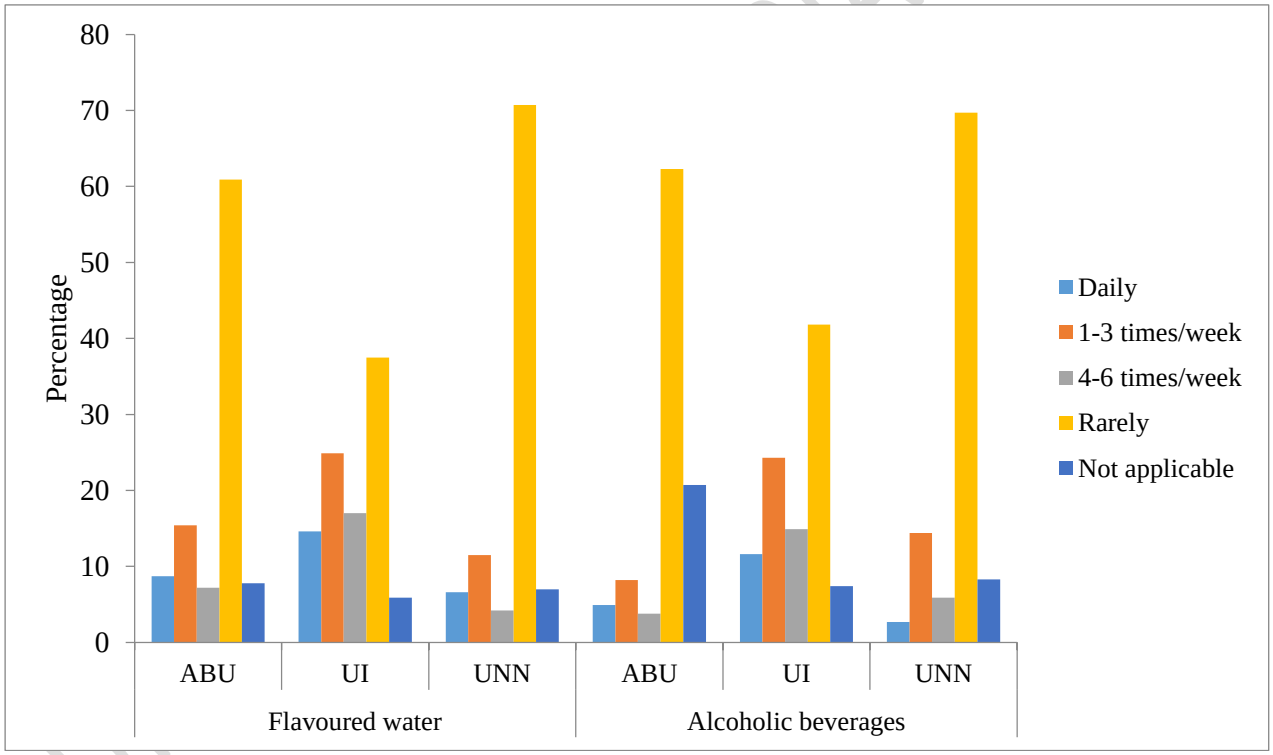

Figure 4.5: Frequency of flavoured water/alcoholic drinks consumption of respondents by institution

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.6 shows the frequency of consumption of zobo and kunu drink of the respondents. A greater percentage (58.7%) of respondents in UNN consumed zobo drink rarely compared to (42.7%) in ABU and (34.6%) in UI. In terms of weekly intake of zobo drink, more (28.7%) students in ABU and (28.9%) in UI drank it 1-3 times than those in UNN (21.9%). Majority (71.5%) of participants in UNN rarely consumed kunu drink as against less than fifty percent (42.8%) of ABU and (44.8%) of UI respondents that rarely took it. Daily intake of kunu were (15.3%) for ABU, (10.3%) for UI and (3.8%) for UNN.

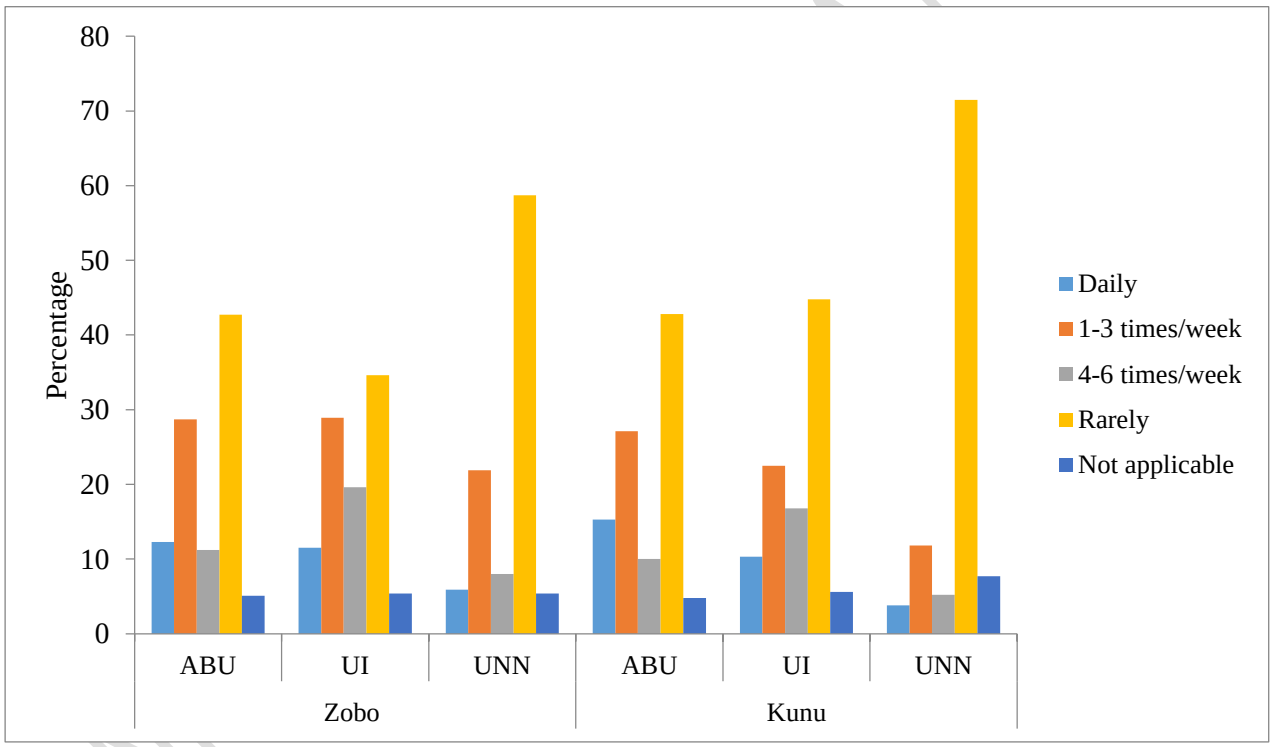

Figure 4.6: Frequency of zobo and kunu drink consumption of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.7 presents the time beverages wereconsumed alone by respondents. More (66.2%) of UI students drank beverages alone than their counterparts in UNN (57.2%) and ABU (43.5%). A good proportion (25.6%) and (22.6%) of the respondents in ABU drank beverages alone in the afternoon and morning, respectively compared with (5.7%) and (20.7%) in UI and (17.2%) and (18.7%) of those in UNN. Respondents in the three universities generally drank fewer beverages at night (5.3% for ABU, 2.5% for UI and 4.2% for UNN).

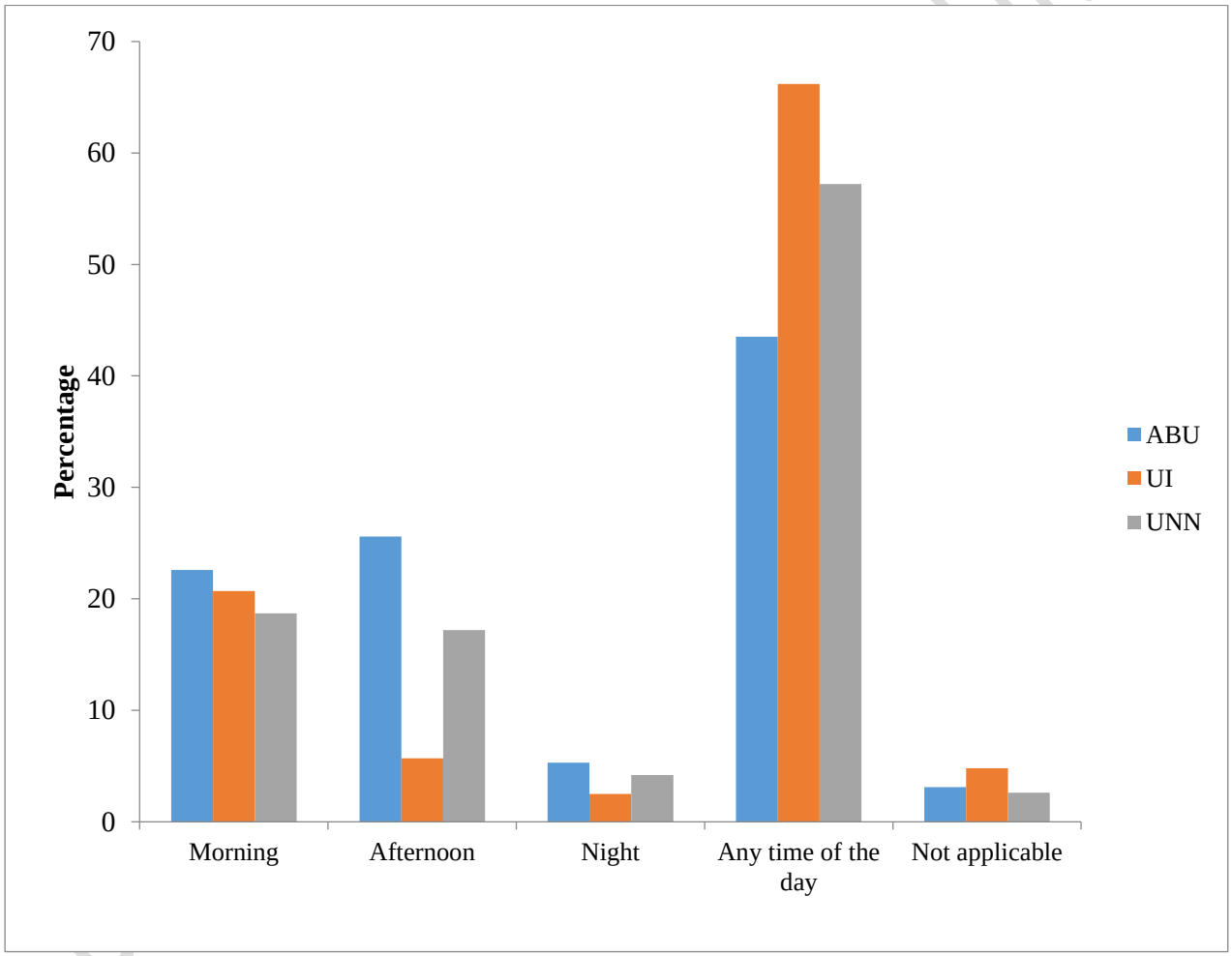

Figure 4.7: Time beverages wereconsumed alone by respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.8 shows the time beverages were consumed with meals by respondents. More than half (52.8%) in ABU, 58.2% in UI and 54.5% in UNN consumed beverages with meals anytime of the day. Whereas less than twenty percent 17.5% in ABU and 18.7% in UNN took their meals with beverages, more than twenty percent (25%) of those in UI did. Again, higher percentage of students (16.5%) in ABU and 15.8%in UNN ate their meals with beverages between breakfast and lunch than 6.1% in UI.These proportions were above those that took meals with beverages between lunch and dinner which were 10.3% in ABU and 8.5% in UNN as against 6.1% in UI.

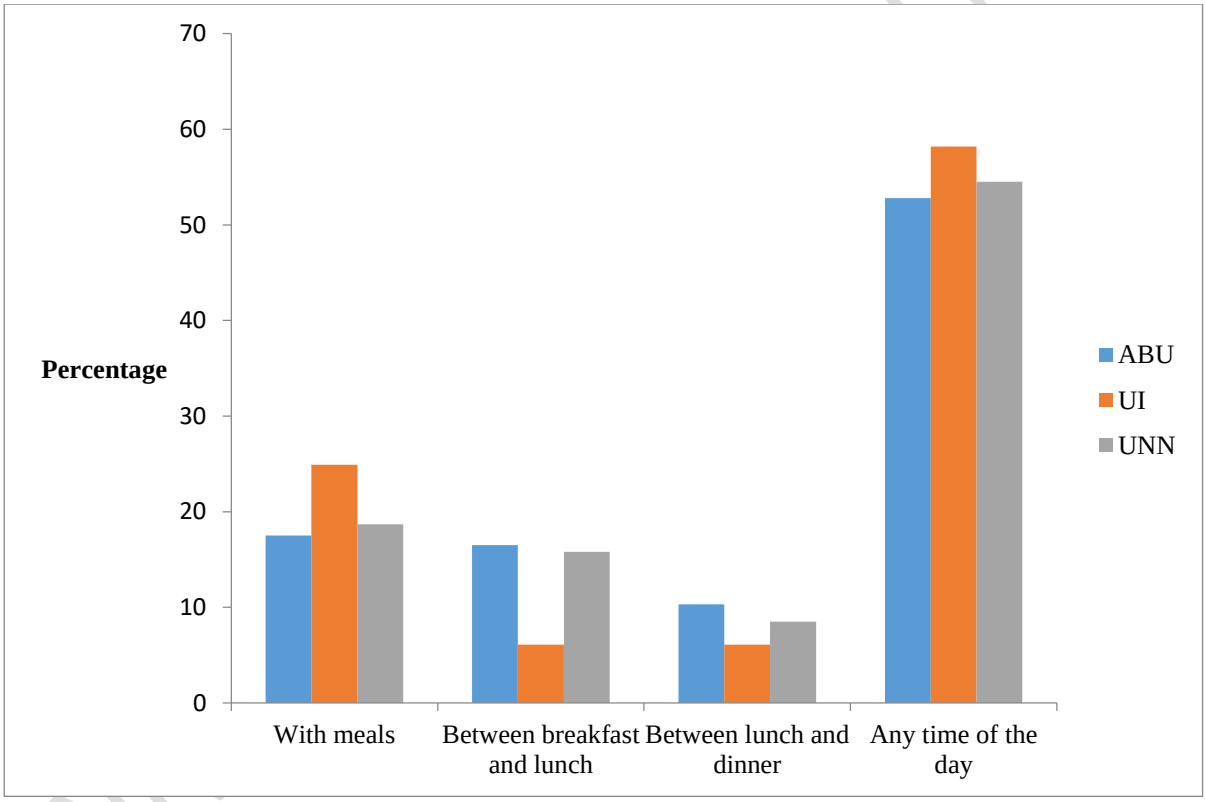

Figure 4.8: Time beverages were consumed with meals by respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.9 presentsthe consumption pattern of cow milk and its products and hot beverageof respondents. Most (44.8% and 64.5%) of ABU, 61.3% and 44.8% of UI and 47.3% and 62.7% of UNN respondents preferred to take milk and its products and hot beverage including milo, bournvita, green tea and others as breakfast. Consumption of milk and hot beverages during dinner constituted the least percentage 14.8% and 11.2% for ABU, 9.4% and 12.0% for UI and 9.1% and 10.4%for UNN, respectively.

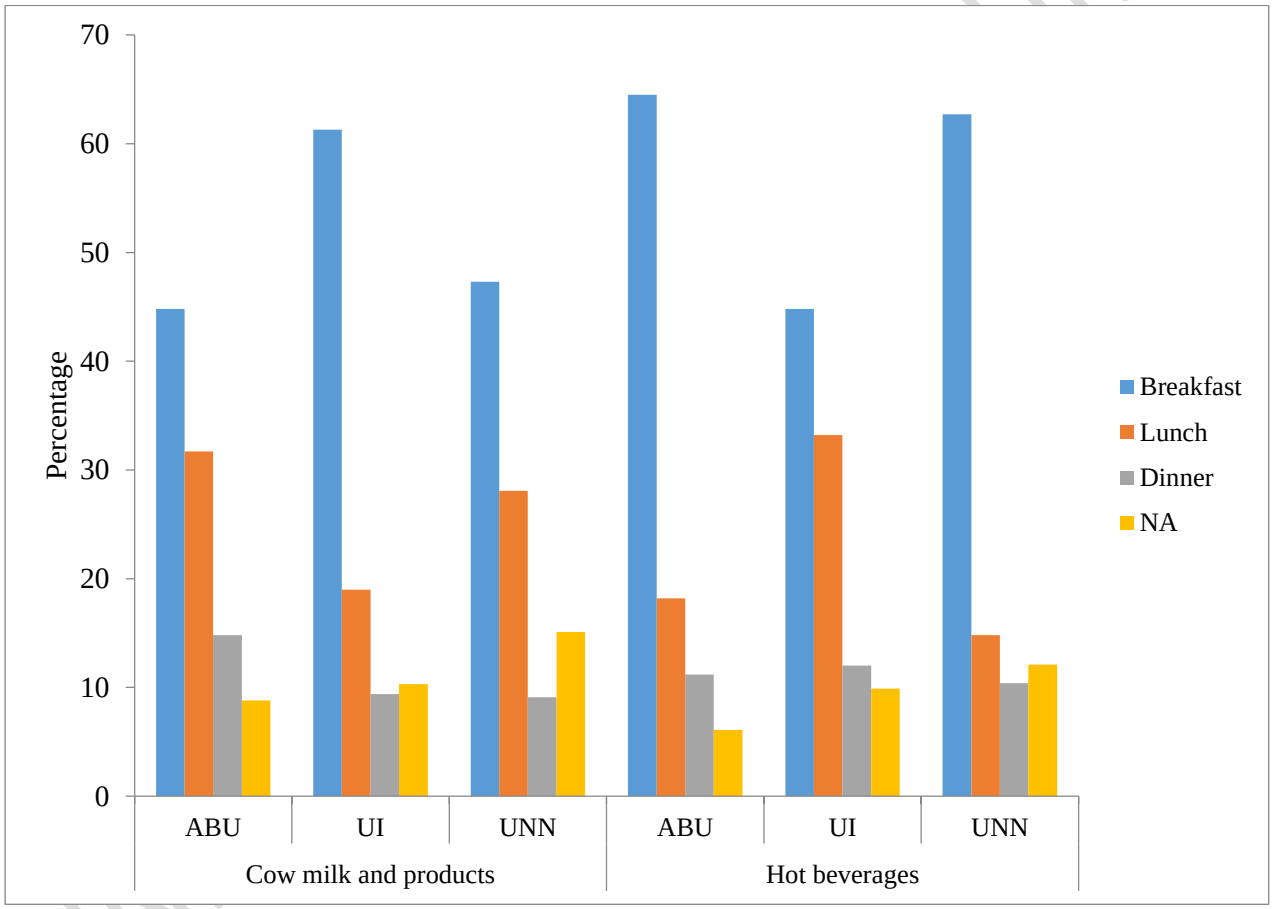

Figure 4.9: Pattern of cow milk/hot beverage consumption of respondents by institution

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.10 presents the consumption pattern of 100% fruit juice and soft drink of respondents by institution. Less than half (48.8%) in ABU, 39.7% in UI and 48.0% in UNN drank 100% fruit juice while having their lunch and only (13.0%) of respondents in ABU and 11.3% of those UNN took beverage during breakfast. High percentage (60.2%) of UNN students and 58.9% of those ABU drank soft drink at lunch compared to 50.5% of respondents in UI. More (20.4%) of respondents in UI took soft drink with their dinner than those in ABU (18.8%) and UNN (18.3%).

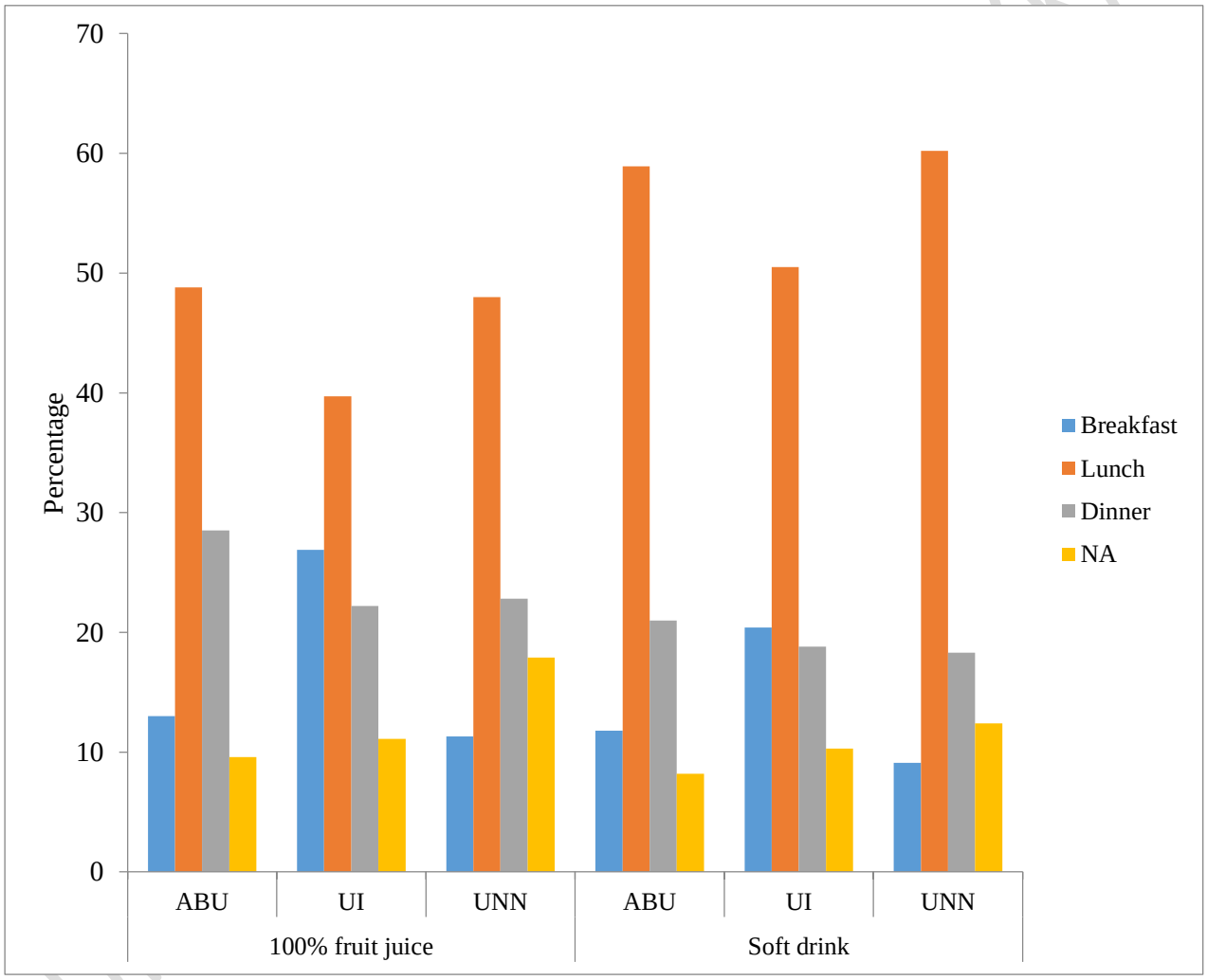

Figure 4.10: Pattern of 100% fruit juice and soft drink consumption of respondents by institution

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.11 describes the consumption pattern of fruit and energy drinks of respondents by institution. Among the three universities, respondents from ABU took more (48.1%) of fruit drink at lunch time, followed by those in UNN (40.9%) and lastly by UI students (39.2%).Less than half (43.8%) in ABU, 42.5% in UI and 42.8% in UNN took energy and sport drinks during lunch. Consumption of energy and sport drink was minimal in ABU (18.9%) and UNN (13.9%) during breakfast than in UI (23.9%).

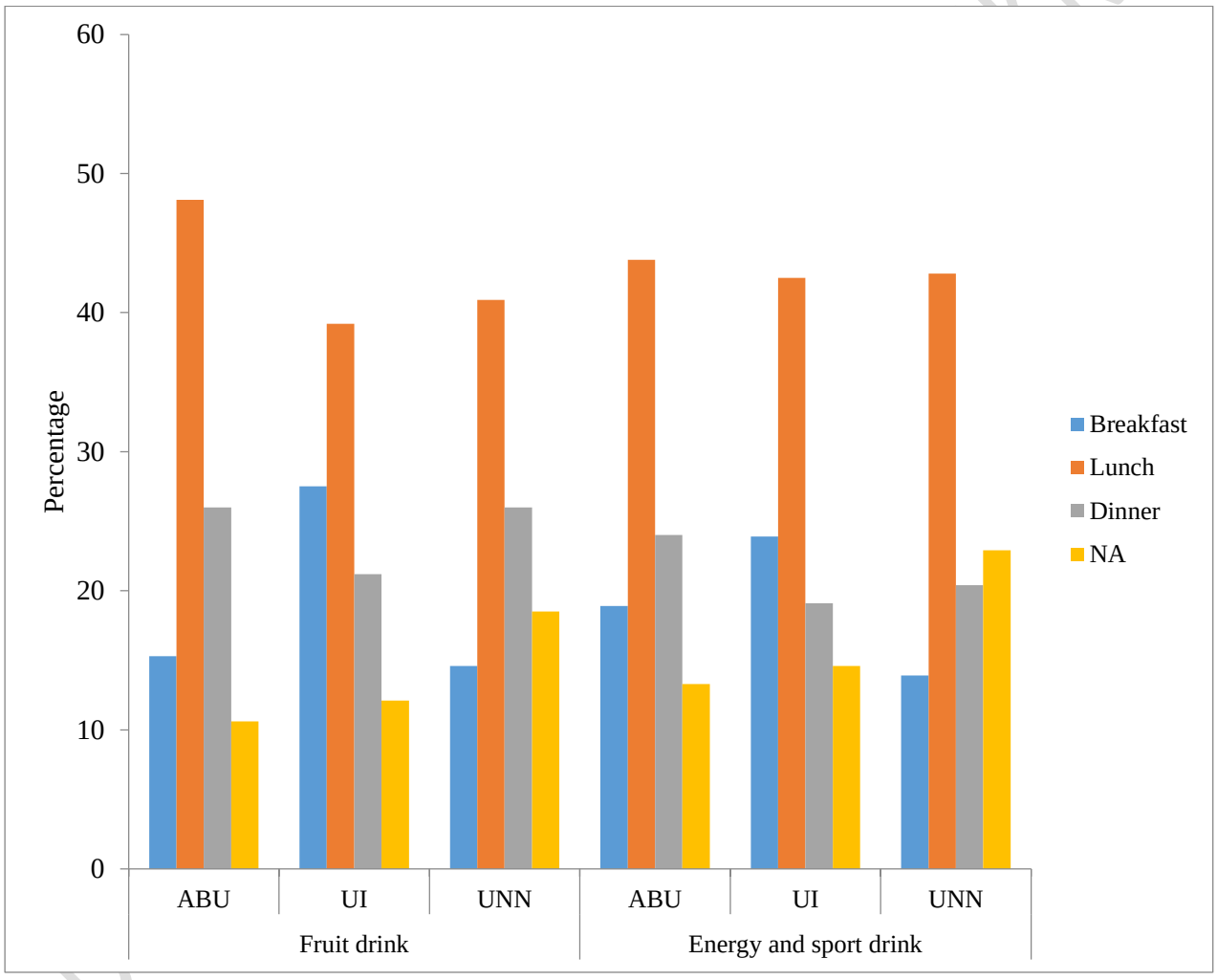

Figure 4.11: Pattern of fruit/energy drink consumption of respondents by institution

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.12 shows the pattern of consumption of malt and flavoured water of the respondents by institution. Forty-seven percent (47%) in ABU, 38% in UI and 41% in UNN drank malt drink and less than forty percent (38.1%) in ABU, 37.0% in UI and 35.1% in UNN took flavoured water during lunch. Generally, respondents from ABU (28.4% and 26.9%) and UNN (26.9% and 22.6%) took more of these two beverages at night with dinner and this was at variance with the pattern in UI where students drank more (24.8% and 25.4%) of these beverages in the morning at breakfast. More (20.3%and 28.4%) of the students in UNN, in relation to few (11.5% and 16.4%) in ABU and (13.4% and 15.9%) in UI did not take malt and flavoured water, respectively.

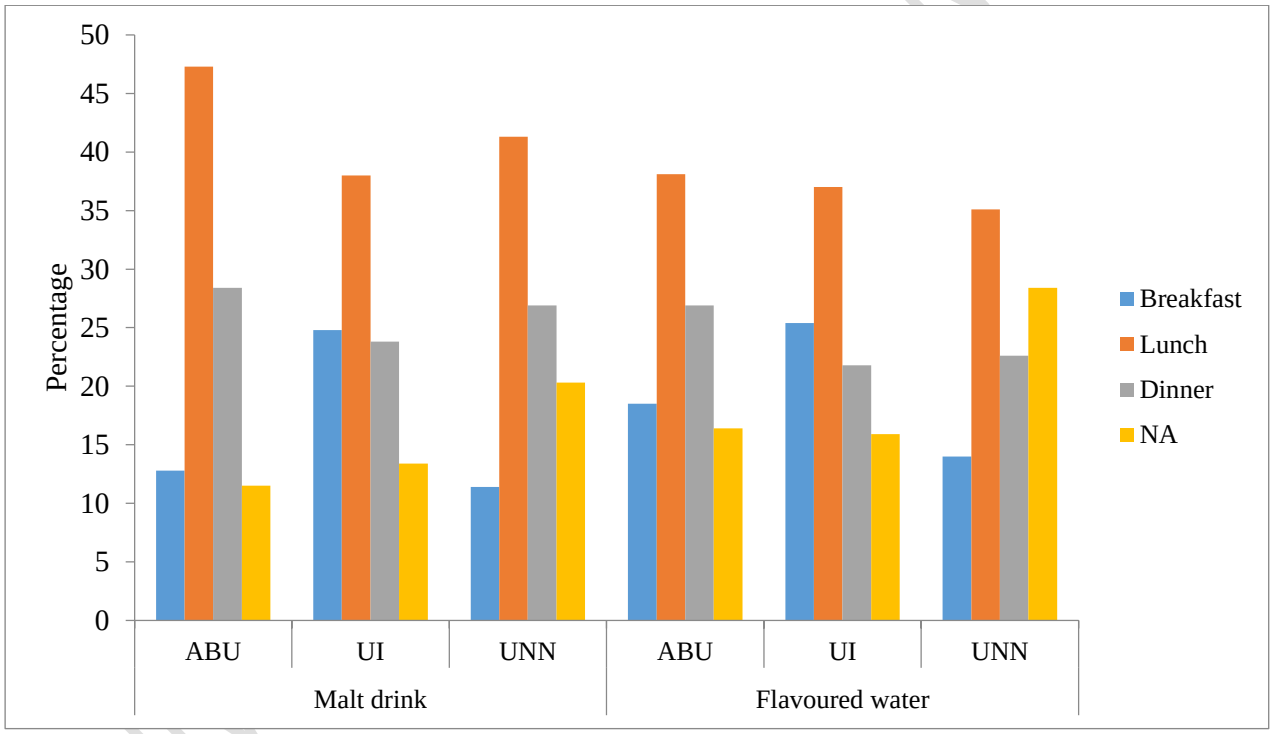

Figure 4.12: Pattern of consumption of malt and flavoured water of the respondents by institution

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka, NA = Not applicable

Figure 4.13 shows the consumption pattern of alcoholic beverages, zobo and kunu drinks of respondents by institution. A greater percentage (40.7%) of respondents in ABU did not consume alcoholic beverages. More students in UNN (34.5%) drank these beverages during dinner while only 31.4% in UI took them during lunch. Respondents in UI consumed twice (22.6%) of alcoholic beverages during breakfast than those in ABU (9.1%) and UNN (6.1%). More (54.8% for ABU, 45.4% for UI and 52.1% for UNN) drank zobo alongside with lunch. More (21.4%) of students in UI also consumed zobo at dinner compared to 18.0% in ABU and 16.3% in UNN. Kunu was taken during lunch by 46.7%, 42.1% and 42.9% of the respondents in ABU, UI and UNN, respectively.

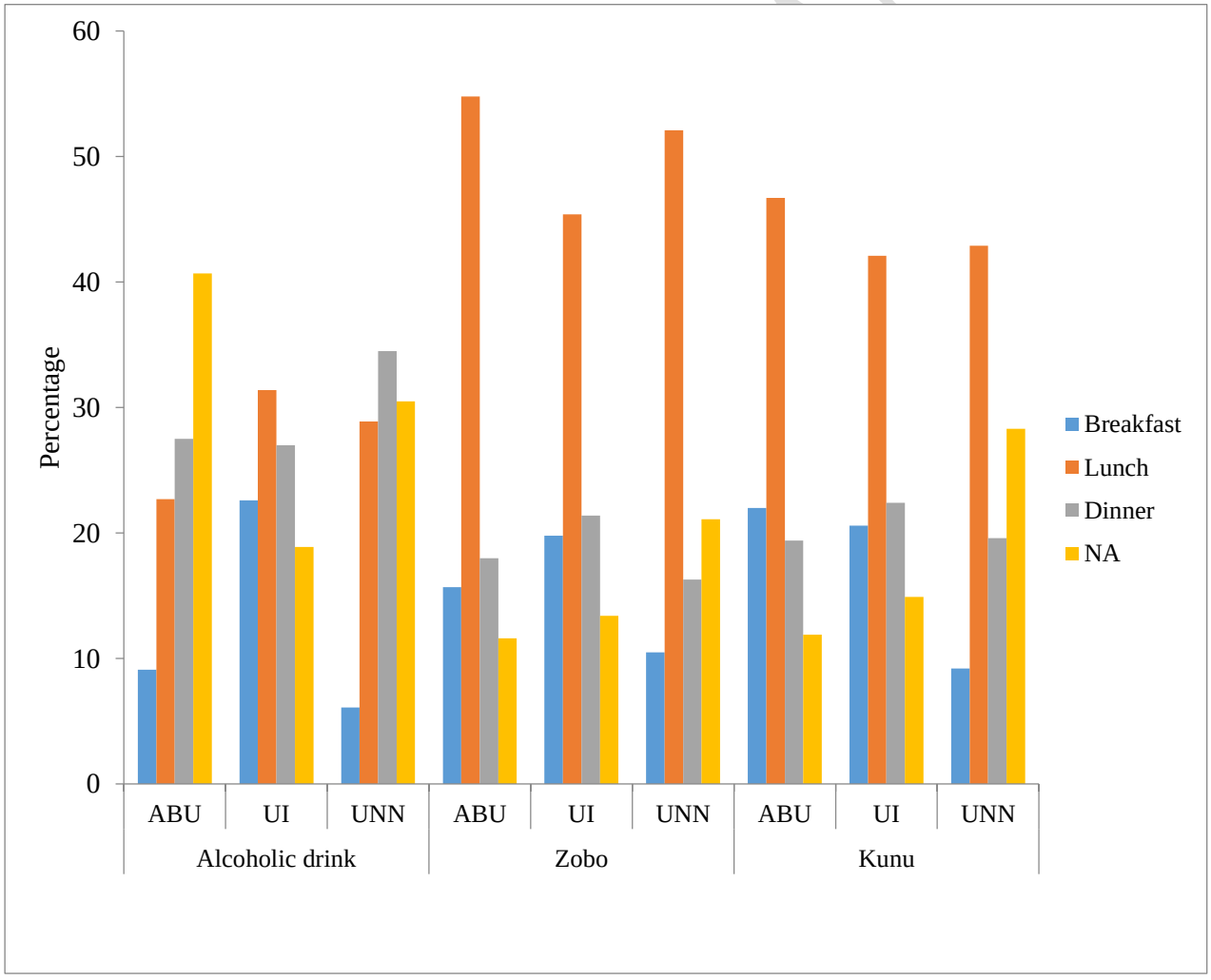

Figure 4.13: Pattern of alcoholic, zobo and kunu drink consumption of respondents by institution

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka, NA = Not applicable

Figure 4.14delineates the influence of cost and diet/nutrition on water consumption of respondents. While more (31.0%) of the respondents in ABU and (36.7%) in UNN strongly disagreed that cost can affect their water intake, 22.7% of ABU respondents and 24.8% of UNN disagreed. Conversely, a good number (31.5%) of students in UI agreed that cost had influence on the quantity and occasions of water consumption. Across the institutions, less than fifty percent of the students (40.2%) in ABU, 42.5%in UI and 42.8% in UNN strongly agreed that water intake was based on their knowledge of its contribution to adequate diet or nutrition.

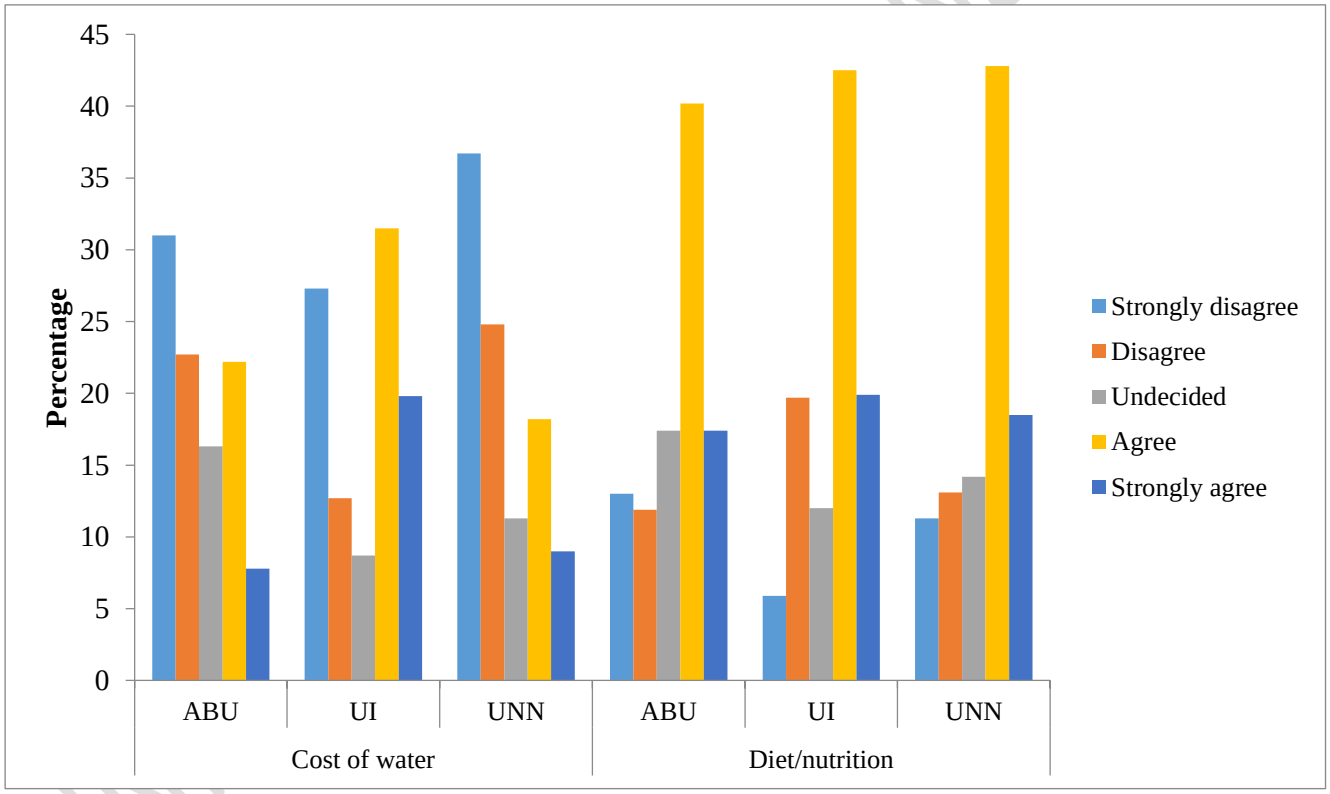

Figure 4.14:Influence of cost and diet/nutrition on water consumption of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.15 shows the influence of availability and perceived health benefit on the water consumption of respondents. The figure revealed that more (40.7% and 19.4%) of ABU students,(39.9% and 26.1%) of those in UI and (44.4% and 19.7%) of those in UNN agreed and strongly agreed that availability of water stimulates an individual's urge to drinking water. Similarly, 42.3% and 21.8% of ABU, 44.7% and 26.7% of UI and 43.1% and 26.4% of UNN respondents agreed and strongly agreed that people drink water to boost their health status.

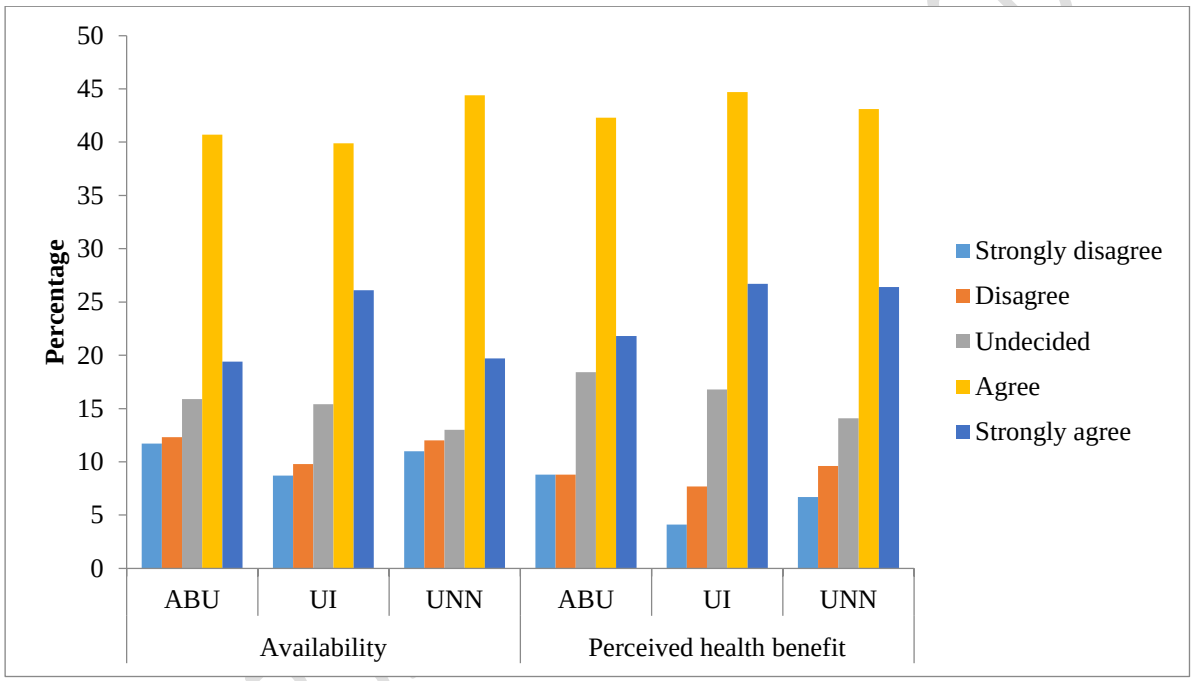

Figure 4.15:Influence of availability and perceived health benefit on the water consumption of respondents.

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.16 describes the influence of exercise and thirst on consumption of water of the respondents. In the three institutions, slightly more than forty percent (42.7%), (41.1%) and (45.7%) of students in ABU, UI and UNN, respectively affirmed that level of exercise or physical activity affects the amount of water consumed. Based on the influence of thirst to water consumption, more respondents in ABU (36.7%) and UNN (44.9%) strongly agreed while more (41.6%) of those in UI agreed. Only few (8.1%) students in ABU, 3.4% in UI and 6.6% in UNN strongly disagreed that thirst affects water intake of humans.

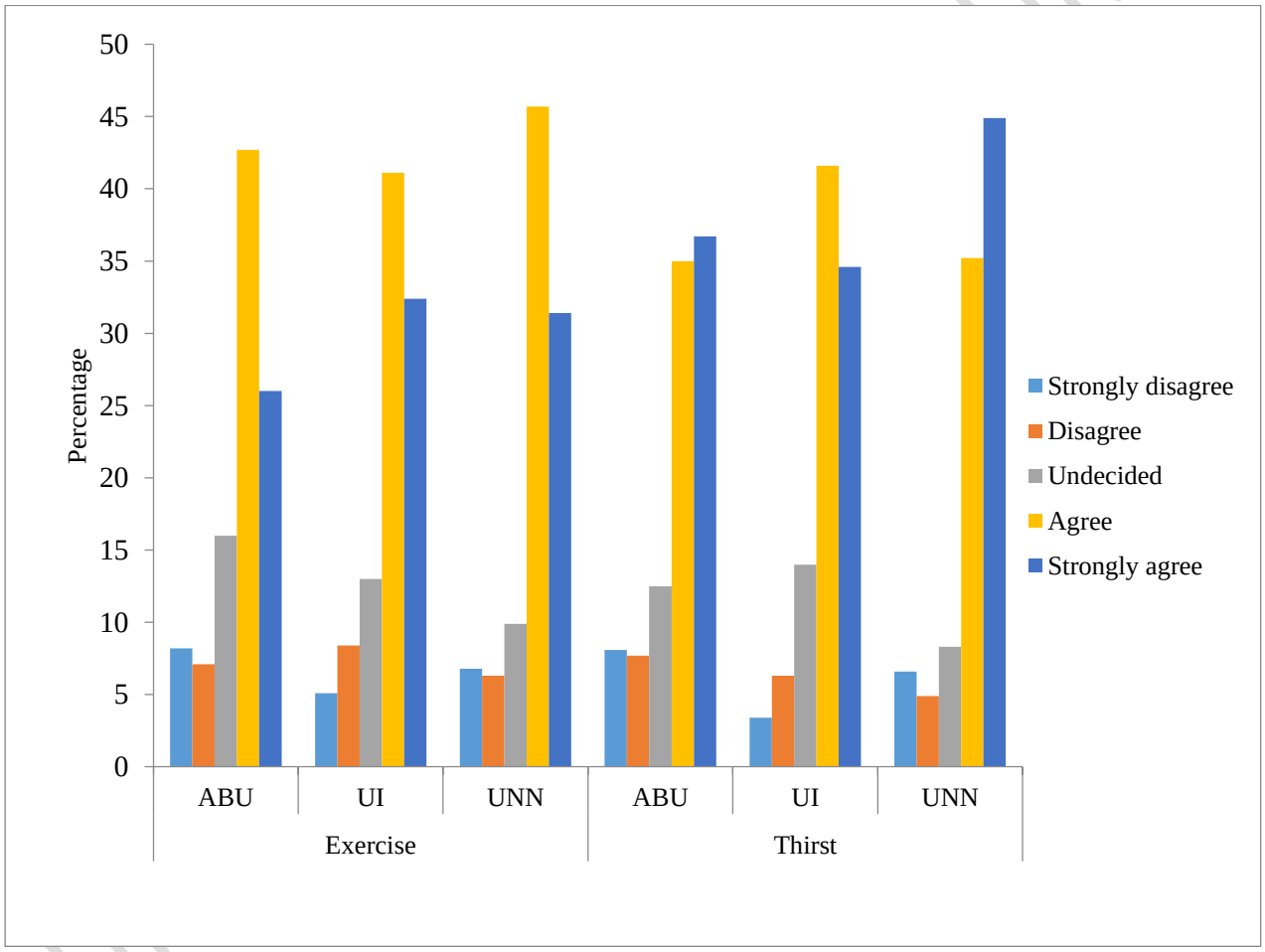

Figure 4.16: Influence of exercise and thirst on consumption of water of the respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.17 shows influence of environment and illness on water consumption of respondents. Less than forty percent (36.7%) of respondents in ABU and (38.4%) in UNN agreed that environmental conditions influenced water intake while slightly more than forty percent (40.2%) in UI agreed. More (42.4%) of UI respondents than ABU (36.4%) and UNN (37.8%) agreed that illness can influence their water intake.

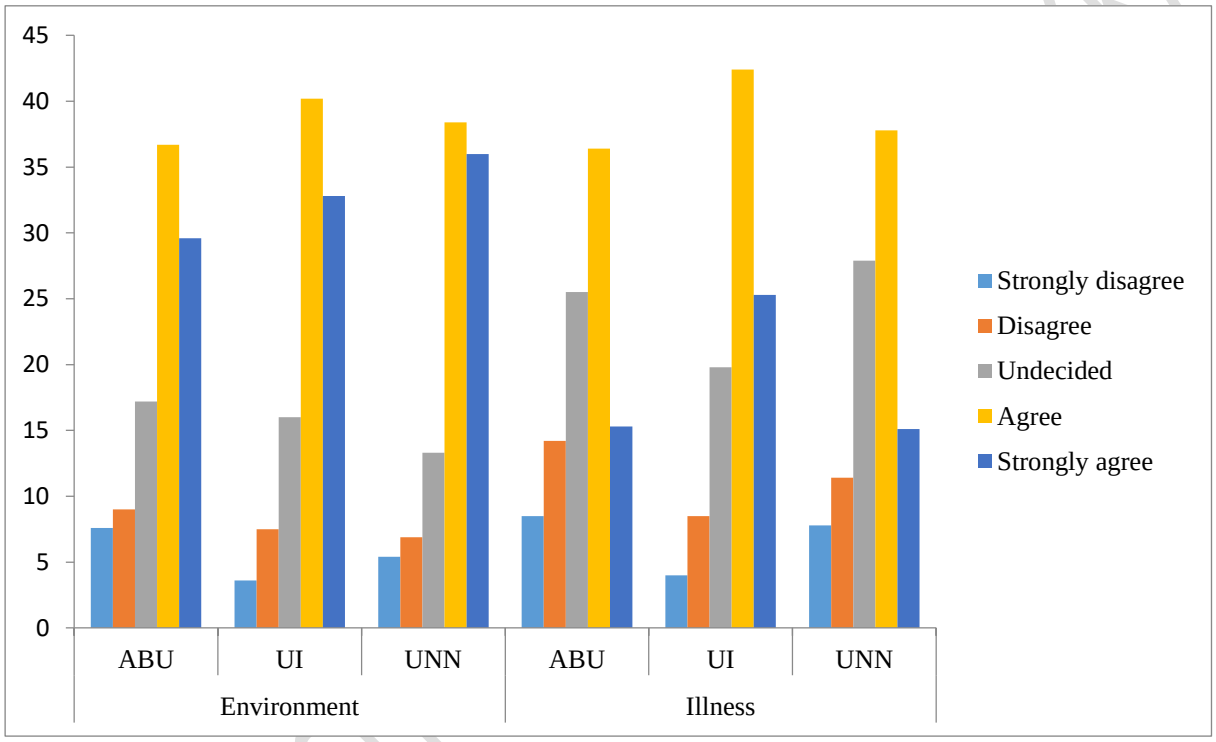

Figure 4.17: Influence of environment and illness on water consumption of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.18 describes the influence of medication on water consumption of respondents. Less than half (42.1% for ABU, 42.4% for UI and 40.6% for UNN agreed that medication influenced the amount of water they take.A significant proportion (27.2%) in UI strongly agreed to the statement that medication affects their water intake compared to 15.9% of respondents in ABU and 18.4% of UNN students. This was followed by a greater percentage 23.1% and 23.3% of participants in ABU and UNN, respectively who were undecided about the effect of medication on their water intake.

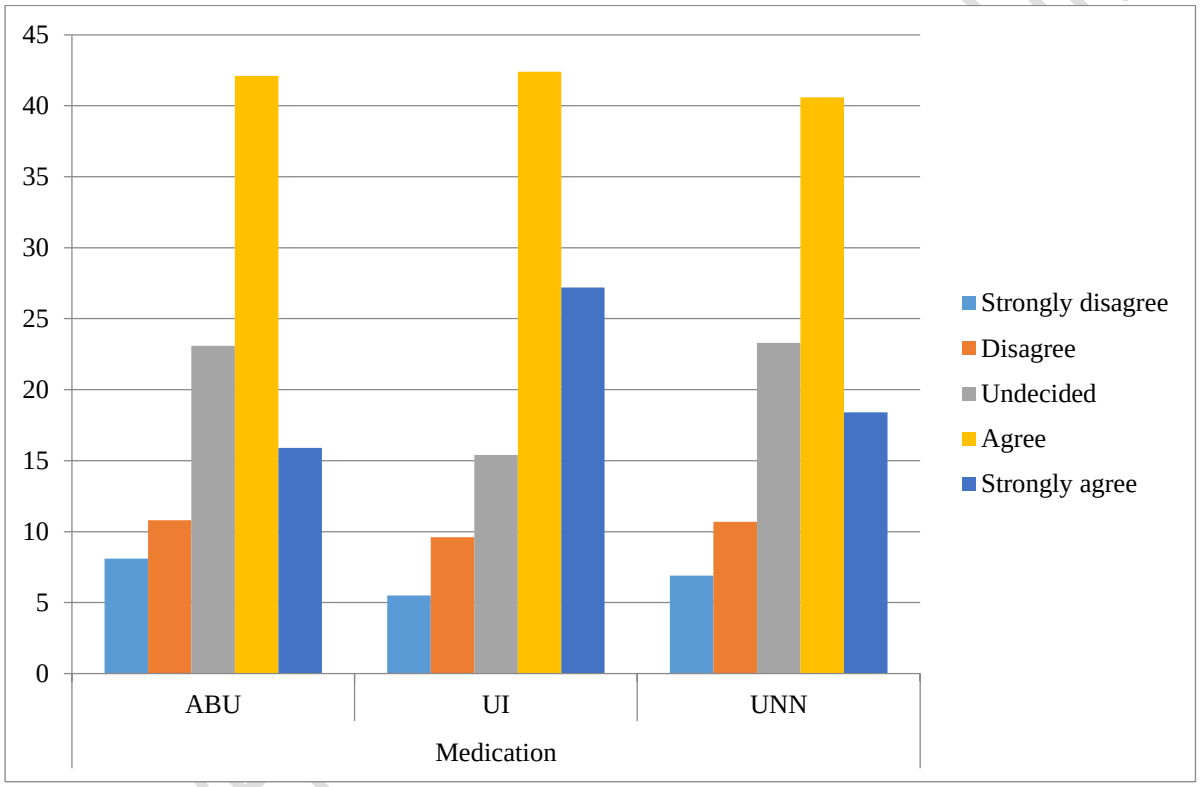

Figure 4.18: Influence of medication on water consumption of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.19 shows the influence of clothing and hunger on consumption of water of respondents. Almost equal percentage (31.3%) of the respondents in ABU and 32.4% in UNN were undecided about the influence of clothing on water consumption while more (38.9%) of those in UI agreed. This result also revealed that 36.4% of students in ABU, 42.1% in UI and 41.3% in UNN greed that hunger is one of the factors that can affect their water consumption.

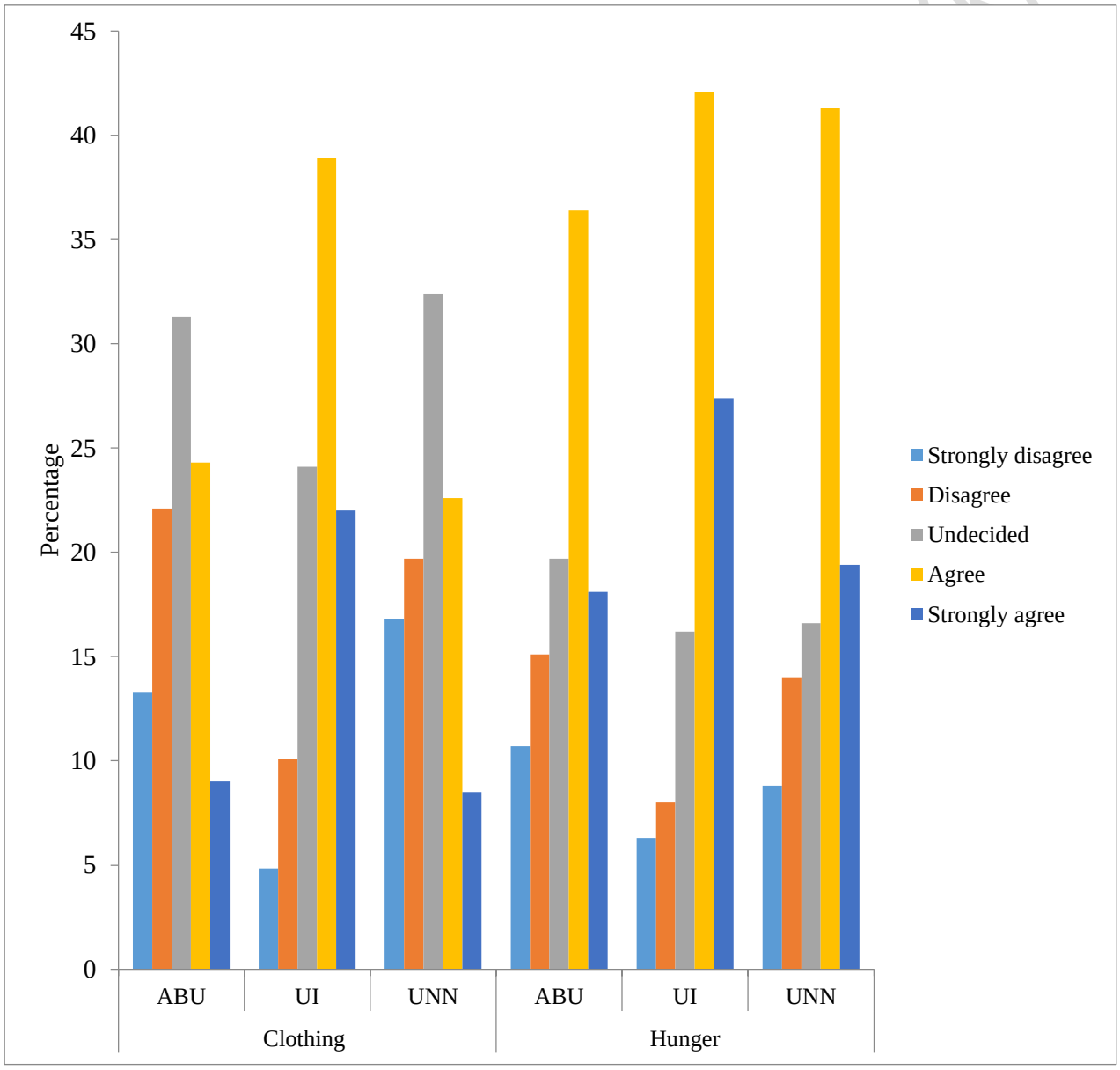

Figure 4.19: Influence of clothing and hunger on consumption of water of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.20 demonstrates the influence of cost of beverage, ability to produce beverage and nutrition label information on beverageconsumption of respondents. Less than forty percent(35.7%) of respondents in ABU, 38.3% in UI and 40.6% in UNN agreed that cost of beverages determined their consumption. As regards the ability to produce beverages, more (44.8%) of UI respondents than 36.9% of ABU and 38.1% of students in UNN agreed that ability to produce a particular type of beverage influenced the level of intake of that beverage. Meanwhile 38.6%, 41.1% and 43.2%of students in ABU, UI and UNN, respectively agreed that their intake of beverage was influenced by the nutrition label information and 14.5% of the respondents in ABU, 12.4% in UI and 14.8% in UNN disagreed.

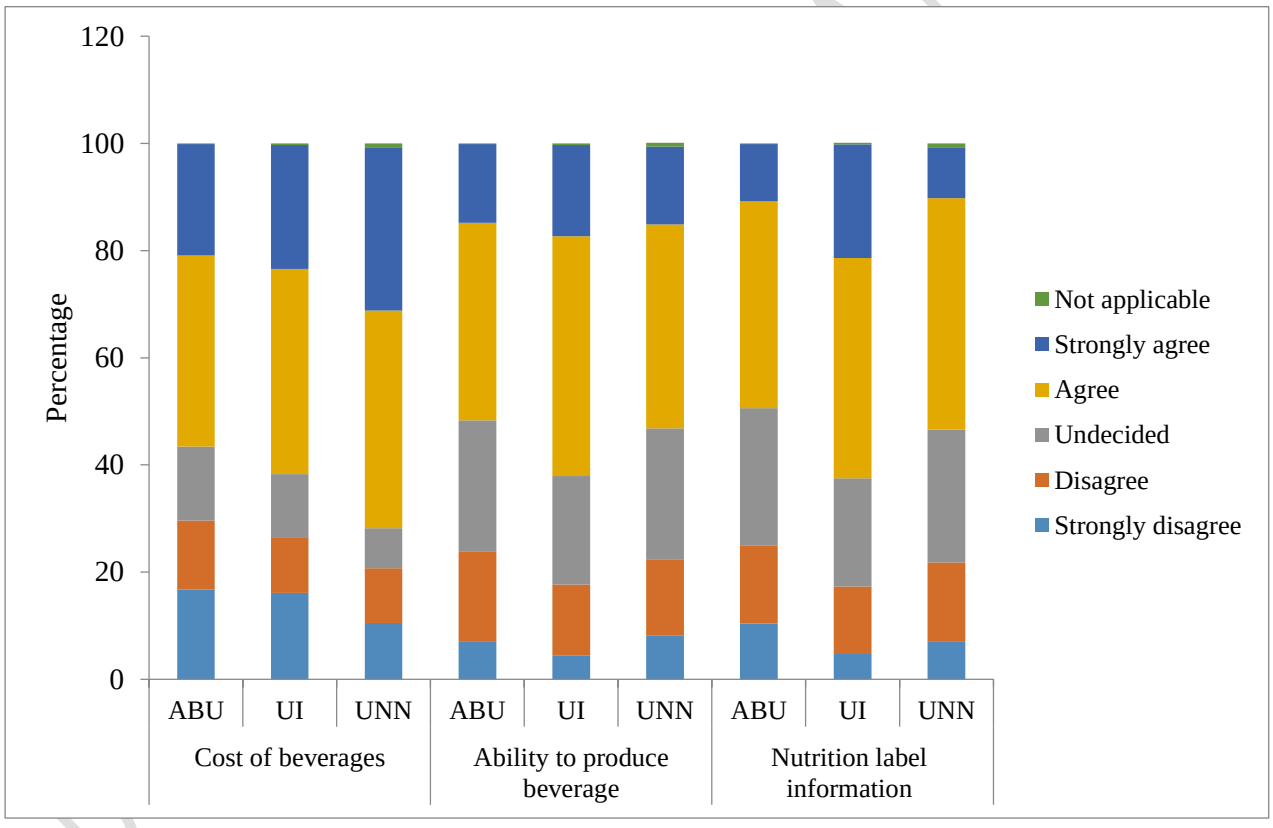

Figure 4.20: Influence of cost of beverage, ability to produce beverage and nutrition label information on water consumption of respondents.

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.21 presents the influence of peer group, having parents who drink and emotion on consumption of beverage of the respondents. Approximately 35%, 40% and 39% of respondents in ABU, UI and UNN, respectively agreed that peer group was an important determinant of the amount of beverage consumed. Some(33.2%) of respondents in ABU, 39.2% in UI and 33.9% in UNN agreed that having parent who drink beverages can affect a child's level of beverage intake. Less than half (32.5%) of respondents in ABU, 40.3% in UI and 34.9% in UNN agreed that emotion influenced their intake of beverage, 28.4% of those in ABU, 23.3% in UI and 24.9% of UNN were undecided.

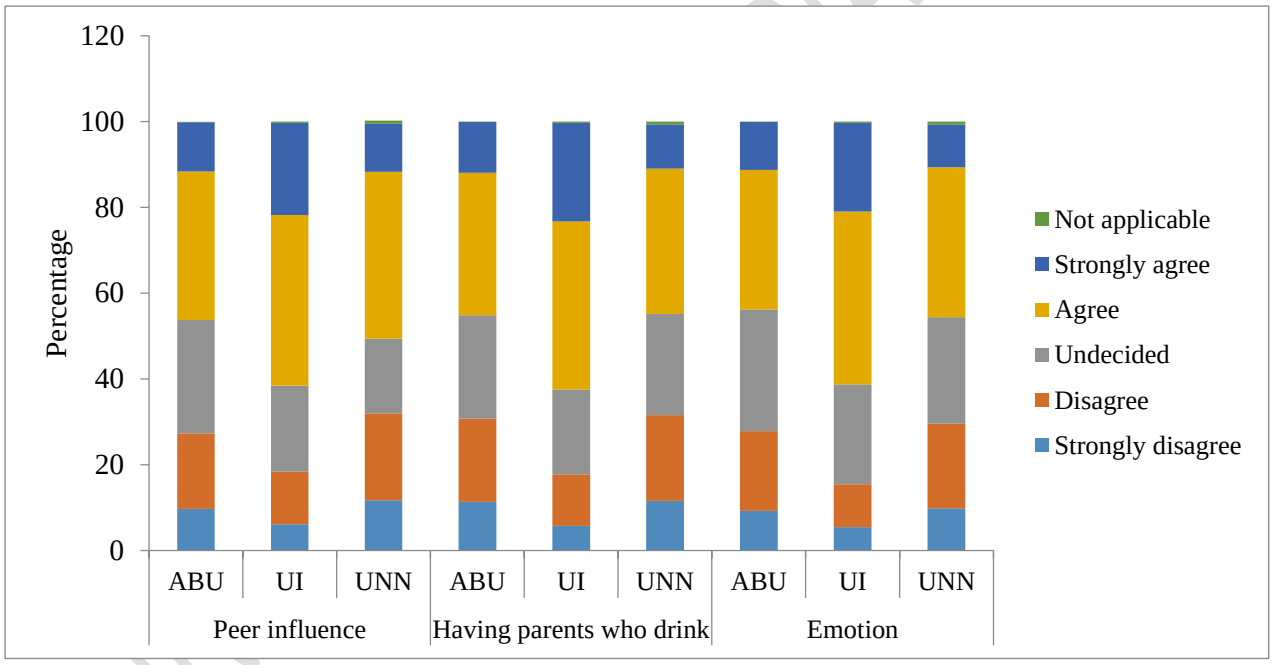

Figure 21: Influence of peer group, having parents who drink and emotion on consumption of beverage of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.22 shows the influence of having no time to prepare meals, studying and travelling on the consumption of beverages of the respondents. Having no time to prepare meals influenced the level of beverage intake of many (38.9%) in ABU, 44.5% in UI and 42.3% in UNN. Almost half (41.3%) of the respondents in ABU, 44.5% in UI and 45.4% in UNN agreed that students drink more beverage while studying while few (13.7% in ABU,8.7% in UI and 14.2% in UNN disagreed. Nearly half (41.7%) of the students in ABU, 44.6% in UI and 43.2% in UNN also agreed that travelling affects beverage intake.

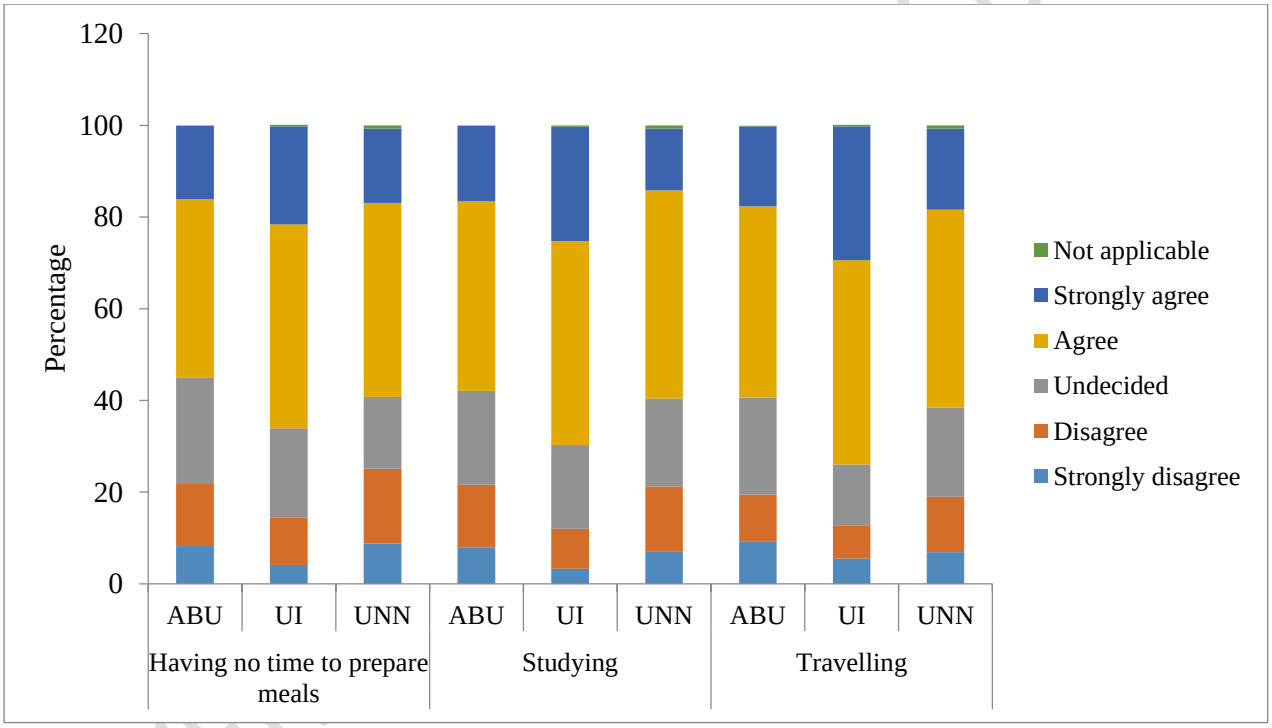

Figure 4.22: Influence of having no time to prepare meals, studying and travelling on the consumption of beverage of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.23 presents the influence of taste, availability of beverage and partying on beverage consumption ofthe respondents. A higher percentage (41.0%), (43.9%) and 46.1% of the respondents in ABU, UI and UNN, respectively agreed that taste of beverage determines its intake. Concerning the influence of availability of beverage to beverage intake, less than half (40.9% in ABU, 42.9% in UI and 45.2% in UNN) agreed that it was one of the factors that can influence beverage consumption of the students. Approximately 31% of the respondents in ABU, 41% in UI and 39% in UNN agreed to the notion that partying affected their beverage consumption and only 11.2% of ABU, 5.5% I UI and 9.4% in UNN strongly disagreed.

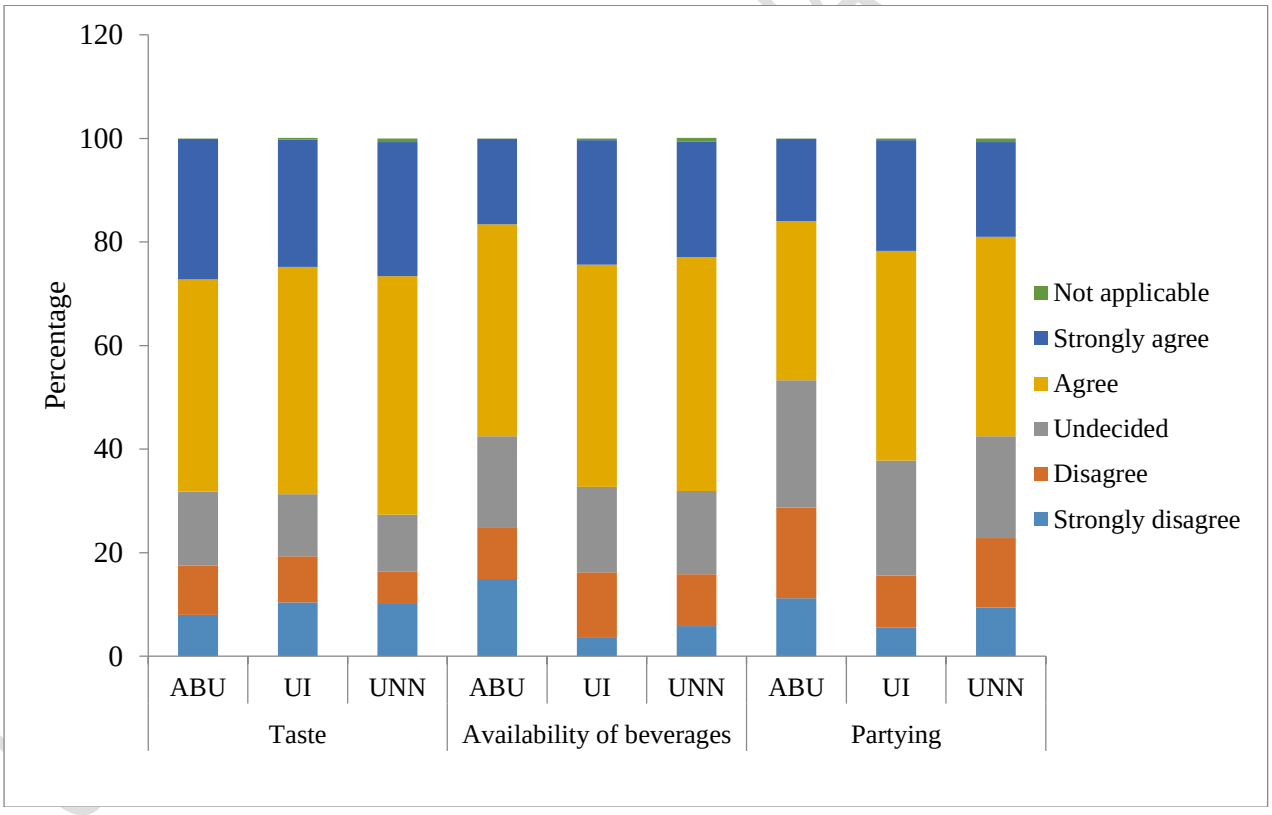

Figure 4.23: Influence of taste, availability of beverage and partying on beverage consumption of respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.24 shows the influence of perceived health benefit, quality and advertisement on beverage consumption of the respondents. Many of the respondents (38%) in ABU, 45% in UI and 44% in UNN agreed that perceived health benefit affected their beverage consumption. Whereas some of the respondents (38%) in ABU, 44% in UI and 46% in UNN agreed that perceived quality can influence beverage intake, less than forty percent (38.7%) in ABU, 37.4% in UI and 37.4% in UNN agreed that advertisement affected their intake of beverage. Few (9.3%), 4.4% and 8.5% of undergraduates in ABU, UI and UNN, respectively strongly disagreed that advertisement had influence on the quantity of beverages they consumed.

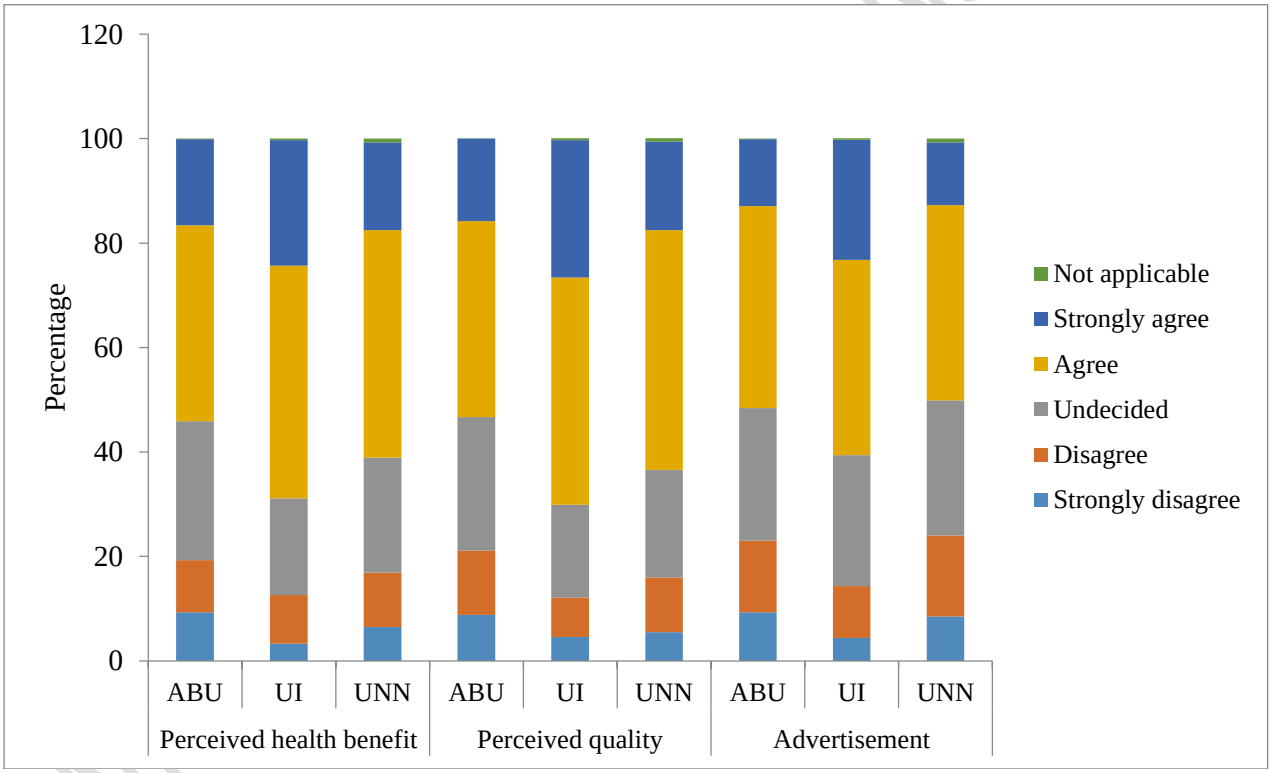

Figure 4.24: Influence of perceived health benefit, quality and advertisement on beverage consumption of respondents.

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka,

Figure 4.25 describes the influence of feeling to drink, drinking to induce sleep and to increase energy on consumption of beverage of the respondents. Whereas less than forty-five (45%) each in ABU and UI agreed that feeing to drink had influence on beverage consumption level of respondents, exactly half (50.0%) of those in UNN supported the thought. Regarding the use of beverage to induce sleep, 30.4% of respondents in ABU, 34.8% in UI and 29.9% in UNN agreed that beverages can be used to facilitate sleep while less than two quarters (40.9%) in ABU, 42.5% in UI and 46.3% in UNN agreed that beverages can be used to increase energy in conditions of decreased energy.

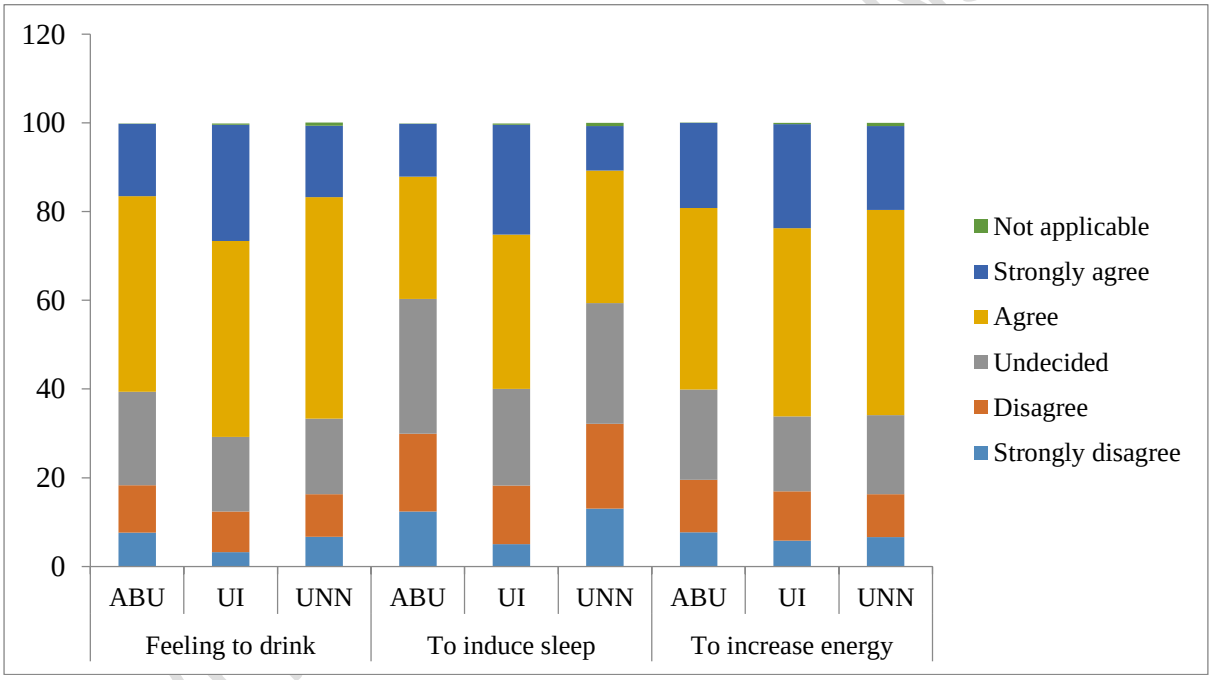

Figure 4.25: Influence of feeling to drink, drinking to induce sleep and to increase energy on consumption of beverage of the respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Figure 4.26 shows the influence of drinking to reduce anxiety/worries and for prestige on the consumption of beverages of the respondents. Only (32.6%) of students in ABU, 37.2% in UI and 31.0% in UNN agreed that beverage can be consumed to reduce anxiety or worries while some (15.2%) for ABU, 15.6% for UI and 19.2% for UNN disagreed. The effect of prestige on the type of beverage consumed was found to be accepted by less than thirty percent (28.9%) of respondents in ABU, followed by 26.4% in UI and lastly by 21.4% in UNN. However, among the three institutions, more (32.0%) of participants in UNN were undecided about the effect of drinking for prestige on the type of beverages taken by university undergraduates compared to those in ABU (28.9%) and UI (26.4%).

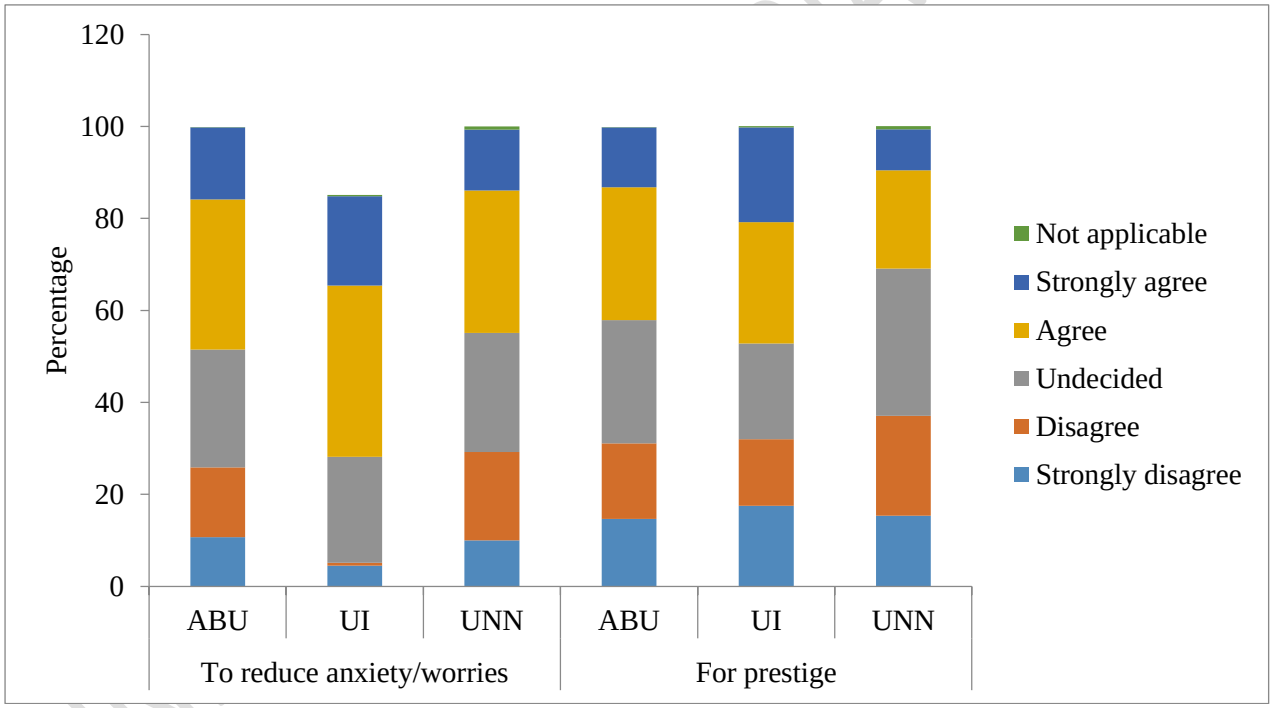

Figure 4.26: Influence of drinking to reduce anxiety/worries and for prestige on the consumption of beverages of the respondents

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka

Table 4.4 shows the daily fluid intake and contribution of water and beverage to the overall fluid intake of respondents by institutions. The mean total fluid intake of (2.40±1.02L) for ABU (2.17±1.16L) for UI and (2.15±0.87L) for UNN were below the maximum and minimum cut-off set (2.6L) and (2.4L) for assessing the optimal hydration and hypohydration of young adults in this study. Mean total water consumption of (1.95±1.06L), (1.66±1.18L) and (1.65±0.85L) and percentage contribution of water for ABU, UI and UNN, respectively was more than the amount supplied by beverages(82%, 77% and 78% vs. 18%, 23% and 22%). However, there was no statistical significance ($p \leq 0.05$) between the total water intake and total beverage intake of the respondents across the three universities.

Table 4.4: Daily total fluid intake and contribution of water and beverage to the overall fluid intake

Variable	**ABU**	**UI**	**UNN**	
	Mean ± S.D	**Mean ± S.D**	**Mean ± S.D**	**P = value**
Total fluid intake (L)	2.39±1.02	2.17±1.16	2.13±0.87	0.41
Contribution of water (L)	1.95±1.06	1.66±1.18	1.65±0.85	0.27
Contribution of beverage (L)	0.43±0.37	0.49±0.35	0.47±0.37	0.703
% contribution of water	82	77	78	
% contribution of beverage	18	23	22	

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
L = litre, S.D = Standard deviation, ± = plus or minus, p = level of significance

Table 4.5 shows the daily total fluid intake and contribution of water and beverage to the total fluid intake of respondents by gender. The mean total fluid intake of female respondents was slightly more (2.27±0.87L) than that of males (2.18±1.15L). While the females met the required recommendation (2.0L) as set by EFSA, they did not meet up to the daily water recommendation set by IOM which is (2.7L). On the part of the males, both of these recommendations (2.5L) and (3.3 or 3.7L) set by EFSA and IOM, respectively were not met. Of the total fluid intake of the respondents, the mean contribution of water 1.76±1.19L for males and 1.72±0.85L for females was more than that of beverage, which was 0.41±0.31L and 0.54±0.40L for males and females, respectively. Percentage water intake (81%)for males and 76% for females were more than that of beverages (19%) for males and (24%) for females. There was no significant difference ($p \leq 0.05$) between the percentage water intake of males and females.

Table 4.5: Daily total fluid intake and contribution of water and beverage to the overall fluid intake of respondents by gender

Variable	**Male**	**Female**	
	Mean ± S.D	**Mean ± S.D**	**P = value**
Total fluid intake (L)	2.18±1.15	2.27±0.87	0.581
Contribution of water (L)	1.76±1.19	1.72±0.85	0.77
Contribution of beverage (L)	0.41±0.31	0.54±0.40	0.703
% contribution of water	81	76	
% contribution of beverage	19	24	

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
χ = chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

Table 4.6 presents the correlation between fluid and beverage intake of the respondents. There was a strong, positive correlation between total fluid intake and total water intake r = 0.935, n= 162, $p \leq 0.001$, with high water intake associated with total fluid intake. There was also a strong, positive correlation between water intake and percentage water, r = 0.55, n = 162, $p \leq 0.001$, with high water intake associated with high percentage water. However, a strong, negative correlation existed between percentage water and total beverage intake r = -0.803, n = 162, $p \leq 0.001$, with high percentage water associated with low beverage intake. These implied that water intake helps to explain 87 percent of the variance of the respondents' fluid intake and 30 percent of the variance of the respondents' percentage water intake, while percentage water helps to explain nearly 65 percent of the variance of the respondents' beverage intake.

Table 4.6: Correlation between fluid, water and beverage intake of respondents

Variable	Fluid intake r (p = value)	Water intake r (p = value)	% water r (p = value)	Beverage intake r (p = value)	% beverage r (p = value)
Fluid intake	1	0.935** (0.000)	0.273** (0.000)	0.112 (115)	-0.084 (0.287)
Water intake	0.935**(0.000)	1	0.550** (0.000)	-0.237** (0.002)	-0.204** (0.009)
% water	0.273**(0.000)	0.550**(0.000)	1	-0.803** (0.000)	-0.398** (0.000)
Beverage intake	0.112**(0.000)	-0.237**(0.002)	-0.803** (0.000)	1	0.347** (0.000)
% beverage	0.084**(0.000)	-0.204**(0.009)	-0.398** (0.000)	0.347** (0.000)	1

** = correlation is significant at the 0.01 level (2-tailed), % = percentage

Table 4.7 shows the relationship between fluid intake and urine specific gravity using Pearson product-moment correlation coefficient. There was a weak, negative correlation between the two variables, r = -0.027, n = 162, p<0.731, with high fluid intake associated with lower urine specific gravity.Similarly, there was a weak but positive correlation between the two variables, r = -0.009, n = 162, p<0.910, with high fluid intake associated with high urine colour and vise verse.

Table 4.7: Correlation between fluid intake, urine specific gravity and urine colour of respondents

Variable	**Fluid intake r (p = value)**	**Urine specific gravity**	**Urine colour**
Fluid intake	1	-0.027 (0.731)	0.009 (.910)
Urine specific gravity	-0.027 (0.731)	1	0.178* (0.023)
Urine colour	0.009 (0.910)	0.178* (0.023)	1

* = correlation is significant at the 0.05 level (2-tailed)

Table 4.8 presents the hydration status of the respondents based on refractometer measurement by institution. Most (88.9%) of the respondents in ABU, 87.5% in UI and 82.0% in UNN were normally hydrated while few (13.1%) and 4.9%) in UNN were slightly and severely dehydrated than 11.1% and 0.0% in ABU and10.7% and 1.8% UI.

Table 4.8: Hydration status of the respondents from the measurements of refractometer based on institution

Urine specific gravity	**ABU**	**UI**	**UNN**	**Total**
	F (%)	**F (%)**	**F (%)**	**F (%)**
Euhydration (≤ 1.020)	40 (88.9)	49 (87.5)	50 (82.0)	139 (85.8)
Slightly dehydrated (1.021-1.029)	5(11.1)	6(10.7)	8(13.1)	19 (11.7)
Severe dehydration (≥ 1.030)	0 (0.0)	1 (1.8)	3 (4.9)	4 (2.5)
Total	**45(100)**	**56(100)**	**61(100)**	**162(100)**
	X^2= 3.036, df= 4, p = 0.552			

ABU=Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
X^2 = chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

The 4.9 shows the hydration status of the respondents based on refractometer measurement by to gender. Higher proportions (81.7%) and 90.0% of males and females were euhydrated. Less than twenty percent (14.6%) of males and less than ten percent (8.8%) of females were slightly dehydrated while very few (3.7%) males and 1.2% females had severe dehydration.

Table 4.9: Hydration status of the respondents from the measurements of refractometer based on gender

Urine specific gravity	**Male**	**Female**	**Total**
	F (%)	**F (%)**	**F (%)**
Euhydration(≤ 1.020)	67(81.7%)	72 (90.0%)	139 (85.80%)
Slightly dehydrated (1.021-1.029)	12(14.6%)	7(8.8%)	19(11.70%)
Severe dehydration (≥ 1.030)	3 (3.7%)	1(1.2%)	4 (2.50%)
Total	**82 (100)**	**80 (100)**	**162 (100)**
X^2= 2.471, df = 2, p = 0.291			

X^2 = chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage
≤ = less than or equal to, ≥= greater than or equal to

Table 4 .10 presents the hydration status of the respondents based on urine colour by institutions. Majority (77.8%) of respondents in ABU, 78.6% in UI and 67.2% in UNN were euhydrated and only few (22.2%) of those in ABU, 21.4 in UI and 31.1% in UNN were dehydrated. More respondents in UNN (31.1%) were dehydrated than those in ABU (22.2%) and UI (21.4%).

Table 4.10: Hydration status of the respondents based on urine colour by institutions

Urine colour	**ABU**	**UI**	**UNN**	**Total**
	F (%)	**F (%)**	**F (%)**	**F (%)**
Euhydration (numbers1,2 or 3)	35(77.8)	44(78.6)	41 (67.2)	120 (74.1)
Dehydration (numbers 4 through 8)	10 (22.2)	12 (21.4)	19 (31.1)	42 (25.9)
Total	**45 (100)**	**56 (100)**	**61 (100)**	**162 (100)**
	X^2= 3.604, p = 0.462			

ABU= Ahmadu Bello University, Zaria, UI= University of Ibadan, UNN=University of Nigeria, Nsukka
X^2= chi-square, df = degree of freedom, p = level of significance, F = frequency, % = percentage

The hydration status of respondents based on urine colour by gender was shown in Table 4.11. Majority (72.0%) of males and 72.2%of females had normal hydration status while only 26.8% and 25.9% males and females, respectively were dehydrated.

4.11: Hydration status of the respondents based on gender

Urine specific gravity	**Male**	**Female**	**Total**
	F (%)	**F (%)**	**F (%)**
Euhydration (numbers1,2 or 3)	59 (72.0)	61(72.2)	120 (74.1)
Dehydration (numbers 4 through 8)	22 (26.8)	19(23.8)	41 (25.3)
Total	**82 (100)**	**80 (100)**	**162 (100)**

X^2 = 1.228, P= 0.541

X^2= chi-square, p = level of significance, F = frequency, % = percentage

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Background and demographic characteristics of respondents

The aim of this cross-sectional study was to assess the hydration status and contribution of water and beverages to the total fluid intake of undergraduate students (16-24 years). It achieved these by determining the socio-demographic status, frequency and pattern of water and beverage consumption, factors that influence water and beverage consumption, 7-day fluid specific record and hydration status of the respondents. Of 3900 respondents selected, 3248 participated with a response rate of 83.3%. Higher percentage of the respondents were males and more than two third were 20-24 years old.

The participation of more males in the present study is at variance with some previous studies. Jacob et al (2013) who had more female participation on the consumption pattern of nutritional health drinks and energy drinks among university students of Ajman United Arab Emirate. Balaghi, Faramarzi, Mahdavi and Ghaemmaghami (2011) recruited higher number of females 142 and males 103 out of a total number of 245 volunteer students participants from Tabriz University of Medical Sciences. Study of Sanni, Badejo and Afolabi (2015) had more female respondents rather than males on beverage consumption pattern among undergraduates of selected tertiary institutions in Abeokuta, Ogun State, Nigeria, respectively.

However, the gender distribution with higher number of males in this study were similar to findings from previous studies of Bipasha, Raise and Goon (2017) on sugar sweetened beverages consumption among university students of Bangladesh that included more males (83.4%) than females (15.9%) and Onongha, (2012) where males represented (52.2%) as against (47.8%) females of their study participants. More than half of the respondent in the present study lived in

the hostel. This study is at variance with the research of Al-Ameri, Al-Badri and Lafta (2016) who found that 84.2% out of 1208 students in their study lived outside the school premises, but in consistent with the study of Ekpenyong et al (2017) who reported that majority of their university students in Akwa-Ibom resided in the hostel.

Most (95.1%) of the respondents were single. This might be attributable to the age of the respondents which included students less than 25 years of age. The present study was similar to the study of Jacob et al (2013) where more than 80% of the respondents were single across all the institutions studied. In terms of the name of the university, a slightly greater percentage of the respondents came from University of Nigeria Nsukka (UNN) with majority being in their first year into the university. This might be attributable to the fact that the researcher was residing in UNN and may have more access to students in UNN coupled with the fact that UNN had the highest proportion of students compared with two others.

More than two third of the respondents received less than ₦25, 000 per monthly from their parents or sponsors as packet money suggesting that many undergraduate students were not buoyant enough and may not afford to buy bottled water. This is in line with the study of Ekpenyong et al (2017) where 44.4% of parents/guardians were from middle socio-economic status and with the study of Idumah et al. (2020) who reported that approximately fifty percent of university students in Ile-Ife earned less than ₦10, 000 as monthly stipend.

5.2 Source of water, frequency and quantity of water consumption each time

Majority of the respondents sourced their water from either tap or bottled water with most respondents from UI and UNN drinking more bottled water than those in ABU where tap water may be available compared to the other two institutions. On the contrary, despite the fact that a good number of respondents from UNN were also in their first years in school, most of them

drank bottled water. This is surprising because majority of them had less than 25,000 as monthly incomes as do those of them in other two institutions. Again, UNN students may not access tap water as much as do their counterparts. However, source of drinking water was statistically different ($p \leq 0.05$) across the three institutions.

The pattern of drinking water can be said to be similar for ABU and UNN where borehole water ranked second to highest. This might be because of the fact that ABU students were majorly in their first years when they may not be so conscious of the health challenges associated with drinking of contaminated water. Whereas respondents from UI in higher educational level may have considered the health implications of drinking tap water irrespective of their monthly allowance. The present study is consistent with other previous study of Saylor et al. (2011) which revealed that perceived risks from drinking tap water and safety, preferred taste and convenience of bottled water were the highest determinants for choosing bottled water over tap water among Purdue University students in US. This implied that price was not considered as a serious factor that influenced their choices.

In addition, some people might think that bottle water may contain more nutrients than tap water. Rosborg (2016) reported that bottled water especially the ones that originated from limestone bedrock have higher concentrations of calcium, magnesium HCO_3 and some micro elements than tap water in Sweden. However, excessive consumption of these minerals through frequent intake of bottled water could predispose individuals to certain health challenges. According to Rosborg (2016) bottled water contained much higher amount of fluoride (12% to 218%) which is more than the recommended intake compared with (0% to 62%) in tap water. However,excessive consumption of these minerals may not pose a problem in the contemporary world as manufacturers of bottled water now employ the use of reverse osmosis in bottle water production. Reversed osmosis refers to the process of using a partially permeable membrane to remove ions, wastes and larger particles from drinking water.

Moreover, poor treatment and long storage coupled with increased temperature of bottled water may have a negative impact on human health. Shotyk, Krachler and Chen (2006) and Allafi (2020) reported that raised temperature contributed to leaching of antimony from polyethylene terephthalate (PET) bottles used in the manufacturing of water bottles and that storing water longer than necessary would lead to more leaching of antimony. Similarly, tap water may also adversely impact human health. A study from the North American Community showed that drinking tap water was responsible for 14% to 17% higher gastrointestinal diseases compared to purified bottled water (Payment et al., 1997). These indicate that neither tap nor bottled water is completely free from contaminations. In Nigeria, there is a dearth of information regarding the safety of tap water and its health implications.

A greater proportion the respondents drank water 3-6 times any time of the day however; some respondents drank less than 3 times daily. The findings were in line with the study of Senterre et al (2014) on fluid intake survey among school children in Belgium which showed that intake of water for at least 3- 4 times/24hrs was a criterion for achieving a state of euhydration. Across the three universities, respondents frequently took 500-600ml (0.5-0.6L) of water at a time. The reason for this might be that water is usually packaged in sachets containing 500- 600 mills and it is easily accessible throughout the campuses.

Besides, it is affordable and generally considered purer than unpackaged water. Although majority of the respondents adopted the pattern of drinking one sachet at a time, more than twenty percent of them especially those from UI and UNN took more than three sachets at one occasion of drinking act. This is in disagreement with those in ABU who preferred taking 2 sachets at once. This might be as a result of respondents in ABU having several alternatives of sources of water like drinking from the tap. The amount of water consumed each time was statistically significant ($p \leq 0.05$) across the three universities.

5.3 Pattern of water consumption of the respondents

The pattern of water intake showed that majority of the students drank water any time of the day suggesting that time did not affect their beverage intake. One of the major reasons for this is that human bodies tend to require water at various times due to changes in physiological conditions, environmental conditions, physical activity levels and/or the type and quantity of food eaten. Despite this uniformity, beverage intake differed significantly ($p \leq 0.05$) from one institution to another as higher respondents from ABU and UNN drank water in the afternoon while those in UI took more water in the morning.

This is not surprising because the northern and eastern regions are known to be cooler in the morning compared to the western region that is often hot throughout the day. Cold weather requires less water whereas hot one would require much water to compensate for high perspiration. A high percentage of the respondents from the three universities were found to drink water while eating and when thirty. It is natural to accompany eating of food with water in order to prevent choking and to drink water when thirst to quench taste.

However, pattern of drinking water on awakening was different with most respondents from ABU not taking water on awakening and those from UI and UNN practiced drinking water on awakening. In other words, respondents from UI and UNN practiced water therapy much more than those from ABU and this may confirm better health. Regardless of the source of water, studies have shown that the consumption of water has the capacity to decrease energy intake from diet and other sweetened beverages, which may in turn help in maintain the body weight (Stookey, Constant, Gardner & Popkin (2007), Madjd et al., 2018). Besides, water intake may reduce the risk of being exposed to certain chronic diseases including diabetes mellitus type 2.

5.4 Beverage consumption of the respondents by institutions

There was high prevalence of consumption of beverages in this study across the three universities, although very few indicated that they do not take beverages. Consumption of beverages in these universities was comparable with none of the respondents in any of the institution taking more beverage than their counterpart. This has many implications. First, the respondents may be tempted to replace water with beverages at one point or the other. Secondly, quite a significant number of them may be predisposed to some non-communicable diseases including being overweight, obesity, diabetes, high blood pressure that correlates with beverage consumption especially those who are already prone to genetic characteristics to these health conditions.

Furthermore, high intake of beverage by the students might be attributable to many things as follows: (1) it has been known that students frequently consume fast food restaurants and this has been found to be associated with increased consumption of beverages. Ahmed et al (2019) reported that 89.3% of students consumed sugar sweetened beverages (SSB) at least once on daily basis and that frequent intake of fast food was one of the major factors responsible for this high prevalence of SSB intake; (2) non-alcoholic beverage (NABs) is cheap and being recognized as healthier drinks have formed part of peoples' meal. According to Flake and Nzeka (2009) most Nigerians are now aware of the nutritional value of NABs and incorporate them in their usual diets. This study is in line with the study of Bipasha et al. (2017) in which a greater number (95.4%) agreed to drink sugared sweetened beverages. Studies within and outside Nigeria have demonstrated that a greater proportion of students consume non-alcoholic beverages (Islam et al., 2020; Idumah et al., 2020).

5.5 Frequency of beverage intake of the respondents

Among the twelve categories of beverages consumed by the respondents, most students rarely consumed six categories including energy drink, malt drink, flavoured water, alcoholic beverage, zobo and kunu across the three universities. However, more students from UNN relatively took less zobo and kunu. This is not surprising because these two beverages are not commonly found in the south eastern part of Nigeria. Majority of the respondents from ABU and UNN consumed milk and milk products, soybean, 100% fruit juice and fruit drink rarely, while most and equal proportion of students from UI took milk and milk products daily and 1-3 times per week. This implies that students in ABU and UNN need to be encouraged to take more milk and its products so as to improve their nutritional status. Milk is a good source of many essential micronutrients such as calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid (vitamin B5) and may contribute appreciable amount of nutrients to the respondents.

Similarly, most and the same number of students from UI took soybean milk 1-3 times a week and rarely, whereas majority of them drank 100% fruit juice and fruit drink 1-3 times. Regarding the frequency of consumption of hot beverages and soft drinks, most of the respondents across the three universities took them 1-3 times on weekly basis. This study is at variance with a study of Ai Otaibi (2017) in which about 40% of students reported consuming SSBs once daily, and almost one third of them (27.5%) took two or more daily. The majority of them consumed soft drinks 1-3 times weekly while only few took them on daily basis.

The present study disagrees with the study by Majeed (2015) who found that 81% of students in Saudi Arabia drank soft drinks 1-2 times per day. Energy and sport drink were rarely consumed by the respondents in the three universities. This disagrees with the work conducted in Nigeria by Sanni et al (2015) who found the prevalence of energy drink intake among university students to be 43.3%. Low consumption of energy in the study may enhance the quantity and quality of sleep

by the respondents because they contain high amount of caffeine (about 50-505 mg/serving) (Ai Otaibi et al., 2017). Hence, they influence an individual's quantity of sleep including the duration and quality such as sleep latency, efficiency and distractions (Calamaro, Mason & Ratcliffe, 2009).

In the present study, more than two-third of the respondents rarely took alcoholic beverages indicating that only few of the students consumed them. This is surprising and may be attributable to under-reporting associated with human studies. This result appeared to be different from other previous studies conducted within and outside Nigeria among the undergraduates which reported high alcohol intake. Cherian, Mboweni, Mabasa and Mafumo (2014) showed that 72.5% of undergraduate students in the University of Utapia, in South African drank alcohol.

El-Ansari, Salam and Suominen (2020) reported that 46% of the students spent long hours drinking, 50% drank large quantity, (41%) had high frequency of drinking, 66% had heavy episodic drinking, and 29% had problematic drinking while (9%) were alcohol dependence.Ajayi, Owolabi andOlajire(2019)reported a current high prevalence of 31.1% alcohol use among Nigerian university students. It can be inferred from this study that depression, liver and brain, poor academic performance, and the consequent dropping out of school due to poor grades, and compromising the academic mission which are associated with high alcohol intake among university students would be uncommon among the study participants.

5.6 Time of beverages were consumed alone and with meals by the respondents

More than fifty percent of the respondents in the three institutions took beverages alone or with meals any time of the day. This suggests that time was not considered as a factor that can affect their intake of beverages. However, respondents in ABU drank more beverages alone in the morning and afternoon compared to those in UI and UNN and students in UI consumed beverages with meals than respondents in ABU and UNN.

5.7 Pattern of beverage intake of respondents by institutions

The pattern of consumption of beverage including soft drink, 100% fruit juice, fruit drink, energy drink, malt drink, flavoured water, zobo and kunu occurred mainly during lunch across the three universities. In contrast, milk and milk products and hot beverages were mostly taken as breakfast from the three universities. This might be attributed to the fact that students may not have ample time to prepare other kinds of food that will require more time since most lectures starts early in the morning. Therefore, they choose to take beverages, which are convenience. One notable practice among these respondents is that those who consumed higher percentage of milk consumed less of other beverages such as soft drink, hot beverages, fruit drink, energy and sport drinks and zobo.

The present study agreed with several studies done in the past by Rajeshwari, Yang, Nicklas and Berenson (2005), Bowman (2002), Storey, Forshee and Anderson (2004), Frary, Johnson and Wang (2004), Ballew, Kuester and Gillespie (2000) and Fisher, Mitchell, Smiciklas-Wright and Birch (2000) which evaluated the relationship between soft drink consumption and milk intake and reported that soft drink consumption was associated with lower intakes of milk and dairy products. However, the consumption of alcoholic beverages did not follow this trend across the universities. Whereas the respondents from ABU and UNN students took them during dinner, those from UI preferred taking them during lunch.

5.8 Factors that influenced water intake of respondents

Although several factors affected the water consumption of the students, a greater proportion of respondents across the three universities agreed to the fact that thirst, exercise, environmental conditions, perceived health benefit and medication ranked highest as factors that could affect an individual’s consumption of water. Some of these factors have been found to influence water consumption in previous studies. Qian (2018) identified safety,hygiene, convenience and

availability of water as factors that mostly influenced water intake of students in Singapore, Hong Kong, and Macau. Physically active students have been reported to drink more water than their inactive counterparts (Alanazi, 2018).As regards cost of water and clothing, whereas many of the respondents from ABU and UNN disagreed that they could influence peoples' water consumption, those from UI agreed to their influence.

5.9 Factors that affected beverage consumption of respondents

Of all the factors listed in questionnaire, respondents across the universities agreed to the fact that taste, travelling, feeling to drink and cost of beverage exerted the greatest influence on their beverage intake while drinking for prestige and to induce sleep constituted the fewer factors that influenced beverage intake of Nigerian undergraduate students. This is in contrast with a previous work by Ayantunji, Ojo and David (2009) which found that although various factors influenced the intake of non-alcoholic beverages among Nigerian students but the most striking ones include convenience of purchase, availability, price, health concerns, and culture or social reasons.

There was a controversy over the influence of prestige and drinking of beverage to induce sleep. Majority of the respondents from ABU were undecided about the ability of beverages to induce sleep, while those from UI and UNN agreed to the fact that beverages could be used to stimulate an individual to sleeping. Taking of beverages for prestige was also debateable among the respondents. Whereas most of those from ABU and UI agreed that undergraduates could choose a particular brand of beverage to show case his/her affluence, those from UNN remained undecided about the point.

5.10 Daily fluid intake, contribution of water and beverage on total fluid intake of respondents

The result revealed that the daily total fluid intake was inadequate compared to the recommended allowance for their age and sex. This study is consistent with the study of Alanazi (2018) in which

students' water intake was 1577mL per day. Water contributed more than beverages to the total fluid consumed by the respondents which also is in line with the study of Zhang et al (2018) who reported that water contributed the highest (74.1%) of the total fluid intake of their participants.

5.11 Fluid intake and contribution of water and beverage to the overall fluid intake of respondents by gender

Fluid consumption of the students by gender indicated that female respondents consumed more fluid compared to males. This is unusual because males are supposed to drink more fluid than female due to the fact that they have more lean body mass and less fat than their female counterparts. Again, in conjunction with the recommendations of WHO, IOM and EFSA, males are expected to take higher amount of fluid than their female counterparts. The present finding was contrary to a study carried out by Alanazi (2018) who reported that being male correlated positively with compliance to adequate consumption of plain water among Montclair State University, but varies with another research of Armstrong, Johnson, McKenzie, Ellis and Williamson (2016) who reported that women took less fluid compared to men (4.80 ±1.28 L Vs. 5.5 ±2.13 L).

5.12 Correlation between fluid, water and beverage consumption of respondents

There was a strong, positive correlation between total fluid intake and total water intake indicating that high water intake was associated with high but a strong, negative correlation existed between total fluid intake of the respondents and total beverage intake with total fluid intake decreasing with increasing beverage intake.

5.13 Correlation between fluid intake, urine specific gravity and urine colour of respondents

From this table, fluid intake of students correlated negatively with urine specific gravity but positively with the urine colour of the students. The present study was in agreement with the study

of Malisova et al (2016) who reported a negatively associated with water intake, specific gravity and urine colour among healthy European adults

5.14 Hydration status of respondents by institutions using both refractometer measurements and urine colour chart matching

The refractometer measurements revealed that most of the respondents across the three institutions were euhydrated. Judging from the urine colour chart majority of the respondents in ABU and UI had normal hydration status than those in UNN while students in UNN were more dehydrated. This is different from the study of Ekpenyong et al. (2017) that reported that (38.6%) and (36.6%) of their study participants had yellow and amber coloured urine indicating a state of dehydration. The discrepancy might be as a result of difference in the area of study, Akwa Ibom which may be cooler than the three regions investigated in the present study. This might also be reason why more respondents from UNN had abnormal hydration status because Nsukka is cold compared to other two universities. Research findings have demonstrated that people living in cooler regions are more likely to drink less fluid compared to those in hot environments.

5.15 Hydration status of respondents by institutions using refractometer measurements and urine colour based on gender

Based on both of the measurements, more females were euhydrated than males while a greater proportion of males had abnormal hydration status including slight and severe dehydrated.

Conclusion

The result of this study demonstrated that there were more male undergraduate and those aged 20-24 years old participated in the study. Monthly allowance of the majority was less than ₦25, 000. Two-third of respondents in all the university consumed water at any time of the day specially while eating food. Nearly all the respondents consumed one type beverage or another with UI students consuming some beverages 1-3 times per week more than their counterparts in ABU and UNN. Taste, exercise and environmental conditions were among the factors that mostly influenced water intake of the students while cost and clothing had the least effect on their water consumption. There was an agreement among the students that beverage intake was influenced by taste, travelling, feeling to drink and cost of beverage while drinking for prestige and to induce sleep constituted the least factors that influenced their beverage intake.

The fluid intake of the students was below the average recommendation for their age and sex. However, most of the respondents had normal hydration status, suggesting that the respondents may have obtained additional fluid from solid foods, fruits and vegetables which were not considered in the present study. Water contribution to the total fluid consumption was slightly higher than that of beverages. This underscores the importance of incorporating school-based nutrition interventions that will encourage more intake of plain water to meet their requirements and reduce beverage consumption in order to prevent the potential health hazards associated with frequent consumption of beverages.

Recommendations

Based on the findings of this study the following recommendations were made:

- There should be behavioural changes on the part of the students especially those from the eastern and northern regions towards curtailing the consumption of beverages with empty caloric values to healthier ones such as milk and its products, 100% fruit juices and fruit drinks to enhance their nutritional status;
- Lecturers should implement school-based curriculum by organizing lectures and seminars on the necessity of optimum intake of water particularly during orientations to expose the new students to the consciousness of staying euhydrated to avoid the adverse effect of dehydration on their academic performances and overall health conditions;
- Parents should initiate and stimulate their children towards reducing beverage intake by decreasing their availability in homes in order to discourage them from consuming unhealthy sweetened beverages;
- Undergraduate students residing in the western part of Nigeria should be encouraged to consume water with their meals and not beverage to prevent the habit of replacing water with beverage;
- Governmental and non-governmental organizations should provide accessible and safe water for Nigerian students on campuses and hostels to ensure adequate availability of the item at any time to improve its consumption;
- Nutrition education to motivate and sensitize students on the importance of sufficient water intake should be disseminated to the undergraduates in Nigerian universities;
- Food manufacturers should enhance the taste of their beverages with nutritious ingredients rather than spend hung amount of money on advertisement and

- Respondents from the west should be enlightened about the dangers of consuming energy and sport drinks in the morning because of their high caffeine content which may be harmful to the body systems.

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Department of Home Science,

Nutrition and Dietetics,

University of Nigeria,

Nsukka.

25th October, 2019

TO WHOM IT MAY CONCERN

I, Onodugo, Nkechinyerem Gift a postgraduate student of the above department wishes to appeal for your compliance as a respondent for my Ph.D thesis. The purpose of the study is to assess the hydration status and contribution of water and beverages to total fluid intake of undergraduate students (16-24 years) in Nigerian Universities. The fluid intake study will take a minimum of 7 days to be completed by each respondent.

Thank you for your cooperation and May God Almighty bless you immensely.

Onodugo, Nkechinyerem Gift

Department of Nutrition and Dietetics,

University of Nigeria,

Nsukka.

CONSENT FORM

I …… from …….. has accepted to partake in the study and has given my consent for my urine samples to be taken to investigate my hydration status.

Sign…… Date…….

TRREE

Zertifikat
Certificat
Certificado
Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Nkechinyerem Onodugo

a complété avec succès - has successfully completed

Training in the Nigerian National Code for Health Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Registration Number: NHREC/TR/08/10/2013A

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Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

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UNIVERSITY OF NIGERIA, NSUKKA

FACULTY OF AGRICULTURE

DEPARTMENT OF NUTRITION AND DIETETICS

QUESTIONNAIRE

Dear respondent, I am a Ph.D student of the above named Department. I am carrying out a research on the **Hydration Status and Contribution of Water and** Beverages to **Fluid Intake of Undergraduate Students in Three Federal Nigerian Universities**

Onodugo Nkechinyerem Gift

Instruction: Tick √ in the box that is most appropriate for your option(s)

SECTIION A: SOCIO-DEMOGRAPHIC STATUS OF THE STUDENTS (16-24 YEARS)

1. Sex: (a) Male ☐ (b) Female ☐
2. Age (in years): (a) 16-19 ☐ (b) 20-24 ☐
3. Region:(a) Northern ☐ (b) Eastern ☐ (c) Western ☐
4. Where do you live? (a) Hostel ☐ (b) Off-Camp ☐
5. Marital status: (a) Single ☐ (b) Married ☐ (c) Divorced ☐ (d) Separated ☐ (e) Widowed
6. Name of university: (a) ABU ☐ (b) UI ☐ (c) UNN ☐
7. Educational level: (A) 100 ☐ (b) 200 ☐ (c) 300 ☐ (d) 400 ☐ (e) 500 ☐ (f) 600 ☐
8. Monthly allowance (₦): (a) Less than 25, 000 ☐ (b) 25,000- 50,000 ☐ (c) Above 50, ☐ 000

SECTION B: FREQUENCY AND PATTERN OF WATER CONSUMPTION OF WATER

9. How often do you drink water every day? (a) Less than 3 times ☐ (b) 3 to 6 times ☐ (c) Above 6 times ☐
10. How much water do you drink each time? (a) 1 Sachet (b) 2 Sachets ☐ (c) 3 ☐ Sachets ☐ (d) More 3 Sachets
11. What time of the day do you like drinking water? (a) Morning ☐ (b) Afternoon ☐ (c) ☐ Night(d) Any time of the day
12. When do you usually drink water? ☐

Variable	Yes	No
On awakening		
While eating		
When thirsty		

SECTION C: PATTERN AND FREQUENCY OF CONSUMPTION OF BEVERAGES

13. Do you drink beverages? (a) Yes ☐ (b) No ☐

If yes, complete the table below:

	Type of beverage	**Frequency of consumption**			
		Daily	**1-3 times/wk**	**4-6 times/wk**	**Rarely**
14.	Cow Milk and milk products (drinkable yoghurt, *fuladenunu*)				
15.	Soybean milk				
16.	Hot beverages (coffee, tea, milo, bournvita, ovaltine,)				
17.	100% fruit juice				
18.	Soft drink (coke, fanta, sprite)				
19.	Fruit drinks				
20.	Energy and sport drinks				
21.	Malt drinks				
22.	Flavoured water				
23.	Alcoholic beverages (wines, beer and spirit)				
24.	Zobo drink				
25.	Kunu				
26.	Other beverages, please specify				

27. When do you usually take beverages (a) With meals ☐ (b) Between breakfast and lunch ☐
(c) Between lunch and dinner ☐ (d) Any time of the day? ☐
28. What time of the day do you like drinking beverage(s)? (a) Morning ☐ (b) Afternoon ☐
(c) Night ☐ (d) Anytime of the day ☐

29. If you take beverages with meals, which meal(s) do you take it with?

	Types of Beverage	**Breakfast**	**Lunch**	**Dinner**	**Others meals, please specify**
30.	Milk and milk products drinkable yoghurt, soybean milk, *fuladenunu*)				
31.	Hot beverages (coffee, tea, milo, bournvita, green tea, ovaltine,)				
32.	100% fruit juice				
33.	Soft drink (coke, fanta, spirite)				
34.	Fruit drinks				
35.	Energy and sport drinks				
36.	Malt drinks				
37.	Flavoured water				
38.	Alcoholic beverages (wines, beer and spirit)				
39.	Zobo drink				
40.	Kunu				
41.	Other beverages, write the name				

SECTION D: Factors that influence the consumption of beverage (please, you can tick more than one factor)

	Factors	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
42.	Cost					
43.	Diet/nutrition					
44.	Availability					
45.	Perceived health benefits					
46.	Exercise/physical activity					
47.	Thirst					
48.	Environmental conditions (temperature, humidity)					
49.	Illness/sickness					
50.	Medications/drugs					
51.	Clothing					

SECTION E: Factors that influence the consumption of beverage (please, you can tick more than one factor)

	Factors	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
55.	Cost					
56.	Ability to produce the beverage type					
57.	Nutrition label information					
58.	Peer influence					
59.	Have parents who drink					
60.	Emotion					
61.	Having no time to prepare meals					
62.	Studying					
63.	Travelling					
64.	Taste					
65.	Availability of beverages					
66.	Partying					
67.	Perceived health benefits					
68.	Perceived quality					
69.	Advertisement					
70.	Feeling to drink					
71.	To induce sleep					
72.	To increase energy					
73.	To reduce anxiety/worries					
74.	For prestige					

A 7-day fluid specific record for assessing fluid intake of students

First Day (D1)

Occasions of fluid intake	Type of fluid	Size of container of fluid	Amount consumed	Place of consumption	Fluid consumed with food	Fluid not consumed with food
On waking from sleep						
At breakfast						
Between breakfast & mid-morning meal						
During mid-morning meal						
Between mid-morning meal and lunch						
During lunch						
Between &lunch mid-afternoon meal						
During mid-afternoon meal						
Between mid-afternoon meal and dinner						
During dinner						
Between dinner and bedtime						
During the night						

A 7-day fluid specific record for assessing fluid intake of students

First Day (D2)

Occasions of fluid intake	Type of fluid	Size of container of fluid	Amount consumed	Place of consumption	Fluid consumed with food	Fluid not consumed with food
On waking from sleep						
At breakfast						
Between breakfast & mid-morning meal						
During mid-morning meal						
Between mid-morning meal and lunch						
During lunch						
Between &lunch mid-afternoon meal						
During mid-afternoon meal						
Between mid-afternoon meal and dinner						
During dinner						
Between dinner and bedtime						
During the night						

A 7-day fluid specific record for assessing fluid intake of students

First Day (D3)

Occasions of fluid intake	Type of fluid	Size of container of fluid	Amount consumed	Place of consumption	Fluid consumed with food	Fluid not consumed with food
On waking from sleep						
At breakfast						
Between breakfast & mid-morning meal						
During mid-morning meal						
Between mid-morning meal and lunch						
During lunch						
Between &lunch mid-afternoon meal						
During mid-afternoon meal						
Between mid-afternoon meal and dinner						
During dinner						
Between dinner and bedtime						
During the night						

A 7-day fluid specific record for assessing fluid intake of students

First Day (D4)

Occasions of fluid intake	Type of fluid	Size of container of fluid	Amount consumed	Place of consumption	Fluid consumed with food	Fluid not consumed with food
On waking from sleep						
At breakfast						
Between breakfast & mid-morning meal						
During mid-morning meal						
Between mid-morning meal and lunch						
During lunch						
Between &lunch mid-afternoon meal						
During mid-afternoon meal						
Between mid-afternoon meal and dinner						
During dinner						
Between dinner and bedtime						
During the night						

A 7-day fluid specific record for assessing fluid intake of students

First Day (D5)

Occasions of fluid intake	Type of fluid	Size of container of fluid	Amount consumed	Place of consumption	Fluid consumed with food	Fluid not consumed with food
On waking from sleep						
At breakfast						
Between breakfast & mid-morning meal						
During mid-morning meal						
Between mid-morning meal and lunch						
During lunch						
Between &lunch mid-afternoon meal						
During mid-afternoon meal						
Between mid-afternoon meal and dinner						
During dinner						
Between dinner and bedtime						
During the night						

A 7-day fluid specific record for assessing fluid intake of students

First Day (D6)

Occasions of fluid intake	Type of fluid	Size of container of fluid	Amount consumed	Place of consumption	Fluid consumed with food	Fluid not consumed with food
On waking from sleep						
At breakfast						
Between breakfast & mid-morning meal						
During mid-morning meal						
Between mid-morning meal and lunch						
During lunch						
Between &lunch mid-afternoon meal						
During mid-afternoon meal						
Between mid-afternoon meal and dinner						
During dinner						
Between dinner and bedtime						
During the night						

A 7-day fluid specific record for assessing fluid intake of students

First Day (D7)

Occasions of fluid intake	Type of fluid	Size of container of fluid	Amount consumed	Place of consumption	Fluid consumed with food	Fluid not consumed with food
On waking from sleep						
At breakfast						
Between breakfast & mid-morning meal						
During mid-morning meal						
Between mid-morning meal and lunch						
During lunch						
Between &lunch mid-afternoon meal						
During mid-afternoon meal						
Between mid-afternoon meal and dinner						
During dinner						
Between dinner and bedtime						
During the night						