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Research article

BIOCHEMICAL ALTERATIONS IN FEMALE UNDER GRADUATES EXPOSED TO COSMETICS: A STUDY OF FEMALE UNDERGRADUATES IN A NORTH CENTRAL NIGERIA UNIVERSITY.

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Abstract

Background: Cosmetics are common product mostly patronized by adolescent and few adult women in Nigeria and globally. The use of these products has been implicated to pose health risks while certain constituents are potentially nephrotoxic or hepatotoxic and dermatologically irritant. Reports on biohazard effects of cosmetic are scanty among juvenile and adolescents' Nigerian users, therefore further study is essential among Nigerian female undergraduates who are chronic cosmetic users.

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Objectives: To study the health implications of acute and chronic bio accumulation of the heavy metals on the kidney and liver functions of cosmetic users

Methods: Anthropometric variables, heavy metals, kidney and liver functions indicators were measured in sixty cosmetics and forty non cosmetics users with standard refence methods

Results: Biochemical indices of the liver and kidney in cosmetic and non-cosmetic users were statistically comparable ($p>0.05$), while the mean values of zinc and copper was significantly elevated in the cosmetic users than in the non-users ($p<0.05$). The relationships between the trace metals, liver and kidney function indices and the duration of usage were not significant ($p>0.05$). Inverse statistically significant relationship exists between the number of cosmetics utilized and duration of usage ($p<0.003$)

Conclusions: There was no evidence of alterations of the renal and hepatic function indices among the cosmetic users.

Keywords. Cosmetics, Cosmetic users, kidney function. Liver function, Biochemical indices, Trace metal

Introduction

Cosmetics are daily routine topical application on the skin of human body like hair, nail, lips and teeth among amongst many others. They are produced for topica application on human body for beautification, promotion of physical attractiveness and also for masking the body odour of the users without changing the body's operational nature [1-2]. Cosmetics are available in different varieties in the market as skin-care creams, powders, lotions, lipsticks, nail polishes, eye and face makeup, deodorants, baby products, hair colourants and sprays [3-4]. They are utilized in large quantity mostly by the women worldwide while some men, mostly adolescent also indulge in cosmetics usage. Heavy metals are part of the constituents of some cosmetics which can be of biological importance provided at concentrations within the tolerated limits [1]. Despite the above benefits, cosmetic recipes still contain some harmful heavy metals and chemicals that are detrimental to human health [5-7]. Asenic, Lead, Cadmium, mercury, copper, and zinc are heavy metals without documented bio-importance [8-9] but has been reported to be very toxic even at very low concentrations through skin penetration of the thinnest area of the facial skin, like peri-ocular areas, and lips. [6, 8,10]. The skin penetration especially through the broken skin and other routes may cause systemic exposure of vital organs like kidney and liver to toxic agents of cosmetics.[11]. This exposure may have extensive effects like nephrotoxic, hepatotoxic, neurotoxic, dermatologic, carcinogenic, mutagenic or teratogenic consequences or implications on the associated internal body organs [1]. These side effects can be fatal among the chronic or addicted cosmetic users, particularly the adolescent female undergraduates who use cosmetics most often in various forms. This age group is more prone to the health risks of cosmetics in Nigeria and other developing countries because of the traits of juvenile delinquency which tends to abuse usage of cosmetics, coupled with poor nutrition, improper **lifestyle,** environmental decadence as well as the variation in the pattern of bio accumulation of the heavy metals in the body's compartments are conditions that exposes bio hazards of cosmetics [12].

Studies on cosmetics and its health challenges on users are most often directed at the heavy metals content and its associated dermatologic implication in the users. Information on the pathologic consequences of bioaccumulation of the heavy metals on the internal organs of the body are scarce despite the daily increase in cosmetic usage and its poor regulations in developing countries. This study on the health implications of acute and chronic bio- accumulation of heavy metals on the liver and kidney is desirable and may be revealing and preventive of further bio-hazards associated with the continuous use of cosmetics. The outcome of this study may curtail the abuse of cosmetics usage among the populace particularly the adolescent female undergraduates in Nigeria Universities.

METHODS

Selection criteria:

Exposed cosmetic users (Study subject):
Sixty apparently healthy female undergraduate students at various levels of study who use cosmetic most often constituted the test subjects.

Non-Exposed and non-cosmetic users (Control): Forty apparent healthy female undergraduates from the same institution who do not use cosmetics were enlisted as control subjects.

Inclusion Criteria: Apparently healthy female undergraduates' student using cosmetic products for up to three years.

Exclusion criteria: Female undergraduate students using cosmetics with underlining liver and kidney health challenges.

Ethical Clearance. This was obtained from the ethical committee of the kwara State University, Molete where the study was conducted.

Consent: This was obtained by structured open-ended questionnaire administered to the subjects to obtain their voluntary consent to participate in the study using the Helsinki ethical principles [13].

Demographic data. Age, marital status, level of study, department, religion, brands of body cream and lipstick used, duration of usage, number of bottles of body cream and lipstick used, awareness of associated health risks was obtained through semi structured questionnaires from the test and control subjects.

Anthropometric data: Weight**, Height** and basal metabolic index (BMI) was measured in both users and non-users of cosmetics using standard methods; **BMI=**Weight (kg)/Height^2 (m^2).

[14].

Clinical data.

Blood pressure: The systolic and diastolic blood pressure of all the subjects was determined with mercury sphygmomanometer following standard procedure**.[15]**

. **Blood sample collection:** Five millilitre (5ml) of fasting (8hrs) venous blood was collected by venepuncture from both study and control subjects into a lithium heparin bottle. Plasma was harvested soon after centrifugation for immediate analysis or stored frozen till when ready for assay

Sample Analysis

Quantitative analysis of serum Zinc and Copper; Zinc and copper in the test and control subjects was quantified using Atomic Absorption Spectroscopy techniques described by Uddin et.al.,[16]

Electrolyte Assay: Serum Na^+&K^+ in both test and control subjects was estimated by flame photometry method described by Garcia et al [17]

Assay of renal function indices

Creatinine. Creatinine in both control and test subjects was estimated by alkaline picrate kinetic method described by Hoste et al.,[18]

Urea estimation; Serum urea in both control and test subjects was estimated by analytical methodology described by _Francis et al., [19].

Uric acid estimation: Uric acid in both test and control subjects was assayed by the principle of Uricase for the determination of uric acid in serum describe by Yunsheng et al.,[20]

Assay of liver function indices:

Total protein estimation: Total protein in both subjects was estimated by the method described by Sapan and Lund [21].

Albumin estimation: Serum albumin assay in both test and control subjects were done by dye binding and immunochemical principles described by Kumar and Banerjee.**[22]**

Bilirubin: Serum bilirubin was assayed in both subjects by direct method described by Lightson and Bachu, [23]

Estimation of the liver enzymes, AST, ALT and Alkaline: Serum Aspartate Aminotransferase (AST/GOT) and Alanine Aminotransferase (ALT/GPT) estimation in both subjects were assayed by spectrophotometric principle described by Huang. et al., [24]

Serum alkaline phosphatase estimation: This was estimated in both subjects by Spectrophotometric principle described by McComb. et al., [25]

RESULT

The results of this study are presented in tables 1-4 and figure 1-13.

Table 1 shows that both users and non-users of cosmetics are in their prime adolescent age range of 20 to 22 years which makes them vulnerable to cosmetic products. The BMI and the blood pressure indicators are within physiological range. Most of the study group have been indulged in using cosmetics for an average of three years.

The values of heavy metals, renal and liver function indices are presented in **Table 2**. The table revealed that the mean concentrations of zinc and copper in cosmetic users were significantly ($p<0.001$) elevated when compared with the control group. The concentrations of the renal and liver function variables in both study and control subjects were statistically comparable ($p>0.05$).

In table 3, Anthropometric, Heavy metals, Renal and Liver functions variables of the menstruating and non-menstruating cosmetic users compared shows that the differences in these variables between the two groups were not significant ($p>0.05$).

Results of the multiple correlations between the variables investigated among the cosmetic users are presented in table 4. Systolic blood pressure has direct correlation with age, BMI and diastolic blood pressure. Copper has direct and inverse relationship with diastolic blood pressure and duration of usage respectively. Age has direct relationship with bottle consumed while BMI., Bottle of cosmetic consumed have direct significant and inverse correlation with age and duration of usage respectively. Other variables have significant correlation with each other but were of little relevance to the present study.

Figure 1 indicates that students in age bracket of 17-20 years (47%) are addicted cosmetics user, while figure 2 revealed that students from the department of Medical Laboratory Science (MLS) were the largest participants most probably because students from this department consented readily to participate in the study and may also be due to their inquisitiveness to have the knowledge of the bio-hazard associated with the use of cosmetic cream. Figure 3 shows that religion is no barrier for the use of cosmetics because there was no

variation in the percentage of cosmetic user between the Muslim and Christian female undergraduates using cosmetics. This might probably be due to the silence on the bio-hazards of cosmetic usage by the religion leaders during religion service or turning of deaf hear to the health implications of cosmetic by the followers of the religion leaders.

Figure 4 indicates that the 200 level students were the highest group of cosmetic users (37.0%). This may be attributed to the peak period of expression of; juvenile delinquency, fun, social character and the joy of being in the University couple with the pride of escaping probation year of studentship in the Nigeria universities. The decline in the use of cosmetics at the 300 and 400 levels (graduating year) of studentship might be an indication of satisfaction of fun associated with the use of cosmetics or awareness of its potential danger. Assessment of the associated health risk awareness of the use of cosmetics is represented on figure 5. 83.5% of the study participants were ignorant of the potential associated health risk, while just few, 16.5% of the undergraduate students claimed to be conscious of the risk. Juvenile delinquency, fun, real and perceived beautification benefits associated with the use of cosmetics might be responsible for the higher percentage of students that lacked awareness of the health risk embedded in the use of cosmetics. The distribution of the students on menstrual period during the study period is shown in figure 6. Most (76%) of the cosmetic exposed students were not on menstrual period during the study, and most probably be an indication that the experimental results might not be influenced by the cyclic physiological variation. The statistical analysis of the duration of the use cosmetics is presented on figure 7, the longest duration of consistent use of cosmetic was twelve months which might precipitate abnormal physiological or biochemical variations in the test subjects. Sivoclair, Caro white and Meschery were the frequently used and most preferred brands of body cream by the participants as presented on figure 8 while the varieties of lip sticks used are presented on figure 9.

DISCUSSION

Exposure to different organic solvents have been reported to cause adverse effects on the functional integrity of different tissues in the biological systems [26]. Similarly, exposure to different heavy metal contents of cosmetics have been linked to various health hazards among users. [27-28]. This study evaluated the effect of prolong exposure to heavy metal contents of some cosmetics on the liver and renal function indices in the adolescent female undergraduates in a Nigeria University.

In this study, plasma levels of zinc and copper in cosmetic users was significantly ($p<0.001$) elevated when compared with the non-user but with no associated significant adverse effect on the liver and kidney function indices of the test subjects as shown in table 2. The non-significant effect of the elevated metals on liver and kidney of the test subjects might be due to self-immunity from the metal toxicants or probably because the heavy concentration reported might be below lethal toxic dose.

The elevation of the trace metals reported is at variance with previous report of Okereke et al., [29]. The increased value of the trace element reported in this work might be due to the low; threshold of absorption, storage or excretion of zinc and copper in our subjects. The duration of exposure of the test subjects to cosmetics preparation in this study might also be responsible for the observed elevated concentrations of the trace elements in cosmetic users (figure 7).

From our findings, the values obtained for liver function parameters were not suggestive of hepatotoxicity (Table 2). The difference in the liver function parameters between the cosmetic and non-cosmetic user groups were not statistically significant ($P>0.05$). All the liver function indicators were within the reference values coupled with the absence of symptoms of any liver abnormalities in the test subjects. The conjugating ability and capacity of the liver were was not compromised as shown by the non -significant values of the conjugated and non-conjugated bilirubin levels reported ($p>0.05$). There was also no evidence of hepatocellular damage among the test group as revealed by the non- significant values of aspartate aminotransferase (AST) and alkaline phosphatase (ALP) with only mild increase in the Alanine aminotransferase (ALT) values. Similarly, the synthetic ability of the liver of the cosmetic users was functioning optimally as shown by the normal values of the total protein and albumin concentration reported which were also statistically comparable with the non-cosmetic users ($p>0.05$).

The Kidney is highly exposed to toxicants due to the high volume of blood flowing through it for purification that may contain toxins deposited in the tubules which can precipitate nephrotoxicity. In this study, kidney function bio markers assayed; urea, creatinine and electrolytes were statistically comparable with the control group. ($p>0.05$). This is an indication that the excretory and conservation functions of the kidney among the cosmetic consumers were optimal and adequate which is indicates that the use of cosmetic may not precipitant nephrotoxicity (Table 2).

The relationship between the duration of exposure to and its effect on the liver and kidney function indices was also evaluated. None of the functional indicators of the two organs have significant correlation with the duration of usage of the cosmetics amongst its users ($p>0.05$) (Table4). This is an indication that cosmetic users are protected from the potential bio-hazards of exposure to the chemical contents of cosmetics. The inverse relationship between the bottle of cosmetic used and the duration of usage may be an indication that the cosmetic users switched to non-cosmetic products probably due to sudden awareness of the potential - bio-hazards of cosmetics or may be due to paucity of fund to sustain the acquisition and use of cosmetic cream. These probabilities and speculations may influence the loss of interest in cosmetic fashion. The inverse relationship between the plasma copper level and duration of usage may indicate that excess copper added to the system via the use of cosmetic is being excreted rapidly to sustain homeostasis and to avoid possible copper toxicity which may be pathologic to healthy living (table 4). This may however require further investigation.

Menstruation is an inevitable periodic physiological process at puberty in women which alters the optimal levels of some biochemical variables while it lasted.[30]. Our findings on table 3 show that the plasma concentration of the heavy metals, renal and Liver functions variables of the menstruating cosmetic users were optimal and statistically comparable with the values in the control subjects ($p>0.05$). This may be an indication that the cyclic menstrual period may not have significant ($p>0.05$) influence on the values of trace metals, liver and renal function indices investigated among the cosmetic users in this study.

CONCLUSION

The use cosmetics is not associated with biohazards and significant pathological changes in the kidney and liver function indices among the female undergraduates in the University studied in the North central region of Nigeria. There was no evidence of nephrotoxicity and hepatotoxicity among the cosmetics users.

CONFLICT OF INTEREST STATEMENT: We declare no potential conflict of interest with respect to the conduct of this research, authorship, and publication of this article.

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Table 1: Anthropometric variables in cosmetic and non-cosmetic users

Variables	**Cosmetic users**	**non-cosmetic users**	p-value
	mean±sd	mean±sd	
	N=60	N=40	
Anthropometric Indices:			
Age[year]	21 .3 8±0.43	22.1.0 ± 0.59	p>0.05
BMI	24.38±0.43	24.15 ±0.44	p>0.05
Systolic blood Pressure [mm/Hg]	117.45 ± 8.83	116.75±9.17	p>0.05
Diastolic blood Pressure: [mm/Hg]	78.31±12.20	79.75±10.98	p>0.05
Bottles of body cream used	4.88±2.80	4.75±2.81	p>0.05
Duration of usage	3.98±1.17	4.48±3.11	p>0.05

Table2: Heavy metals, Renal and Liver function variables in cosmetic and non-cosmetic users

Variables	**Cosmetic users** (N=60)	**non-cosmetic users** N=40	p-value
	Mean±Sd	Mean±Sd	
Heavy metals:			
ZINC (µg/dl)	1.36±0.06	0.96±0.04	P<0.001

COPPER (µg/dl)	0.57 ±0.02	0.41±0.01	P<0.001
Renal function indices:			
Sodium (NA) [mmol/L]	136.90±7.00	138.30±2.10	p>0.05
Potassium(K) [mmol/L]	4.41± 0.25	4.40±0.93	p>0.05
Urea [mmol/L] `	4.09±0.16	4.03±0.0.17	p>0.05.
Creatinine [µmmol/L]	89.62±21.53	84.05±24.40	p>0.05
Uric Acid0.15–0.41 mmol/L	0.28±0.01	0.32±0.02	p>0.05
Liver function indices:			
Total Protein [g/L]	67.08±10.07	80.58 ± 34.66	P<0.005
Albumin [g/L]	41.51±0.77	40.65± 1.12	P>0.05
Total bilirubin	5.48 µmol/L	5.39 µmol/L	P>0.05
Conjugated bilirubin	2. 13 µmol/L	2.12 µmol/L	P>0.05
AST [iu/L]	50.75±30.22	58.54 ±33.22	P>0.05
ALT [iu/L]	26.4000±10.45280	35.0500±26.44	P<0.024
ALP [iu/L]	112..33±3.56	119.30±4.12	p>0.05

Table 3: Anthropometric, Heavy metals, Renal and Liver functions variables in Menstruating and Non- Menstruating cosmetic users.

Variables	Menstruating subjects N=36 mean±sd	Non- Menstruating subjects N=44 mean±sd	p-value
Anthropometric Indices:			
Age[year]	21 .3 8±0.43	22.1.0 ± 0.59	p>0.05
BMI	24.19±3.06	24.46 ± 3.66	p>0.05
Systolic blood Pressure [mm/Hg]	116.67±8.10	117.73±8.86	p>0.05
Diastolic blood Pressure: [mm/Hg]	77.33±17.10	78.64±10.25	p>0.05
Heavy Metals			

ZINC(µg/dl)	94.96±75.06	72.59±7.15	p>0.05
COPPER (µg/dl)	**217.91±15.14**	205.39±11.21	P>0.001
Renal function indices:			
Sodium (NA) [mmol/L]	135.56±8.96	137.39±6.20	p>0.05
Potassium(K) [mmol/L]	5.52±3.15	4.62±2.18	p>0.05
Urea [mmol/L]	1.85±0. .58	1.80±0.61	p>0.05
Creatinine [µmmol/L]	85.7500±13.26	91.02±23.82	p>0.05
Uric Acid0.15–0.41 mmol/L			
Liver function indices:			
Total Protein [g/L]	66.69±10.25	67.23±10.12	p>0.05
Albumin [g/L]	49.50±6.35	51.43±6.79	p>0.05
AST [iu/L]	49.13±28.34	51.34±31.18	p>0.05
ALT [iu/L]	35.27±24.01	28.23±14.27	p>0.05
ALP [iu/L]	134.13±47.10	138.50 ± 57.02	p>0.05

Table 5: Correlation of Liver and Renal function indices with the duration of usage of Cosmetics.

Variables	r-value	p--value	Decision
Total protein (g/l)	0.665	0.057	Not significant
Albumin (g/l)	0.260	0.148	Not significant
Alkaline phosphatase (u/l)	0.362	0.120	Not significant
Alanine Amino Transferase (u/l)	0.618	0.066	Not significant
Aspartate Amino Transferase (u/l)	0.409	-0.109	Not significant
Creatinine (□mol/l)	0.799	0.340	Not significant
Urea (mmol/l)	0.916	-0.410	Not significant
Sodium (mmol/l)	0.301	0.136	Not significant
Potassium (mmol/l)	0.865	-0.220	Not significant
Zinc (□g/dl)	0.532	0.082	Not significant
Copper (□g/dl)	0.865	0.220	Not significant

Bottle used versus Duration	-0.373**	0.003	Significant
Periods Vs Copper	-0.321*	P<.012	Significant

Table 6: Chi-Square to determine association between use of cosmetics and some Anthropometric variables.

Variables	X^2 value	p-value	Decision
Faculty of Cosmetic users	0.372	P>0.05	No association
Level (year) of study	15.478[a]	P>0.05	No association
Religion	1.761[a]	P>0.05	No association
MENSTUATION	3.938[a]	P>0.05	No association
State of origin	34.557[a]	P>0.05	No association

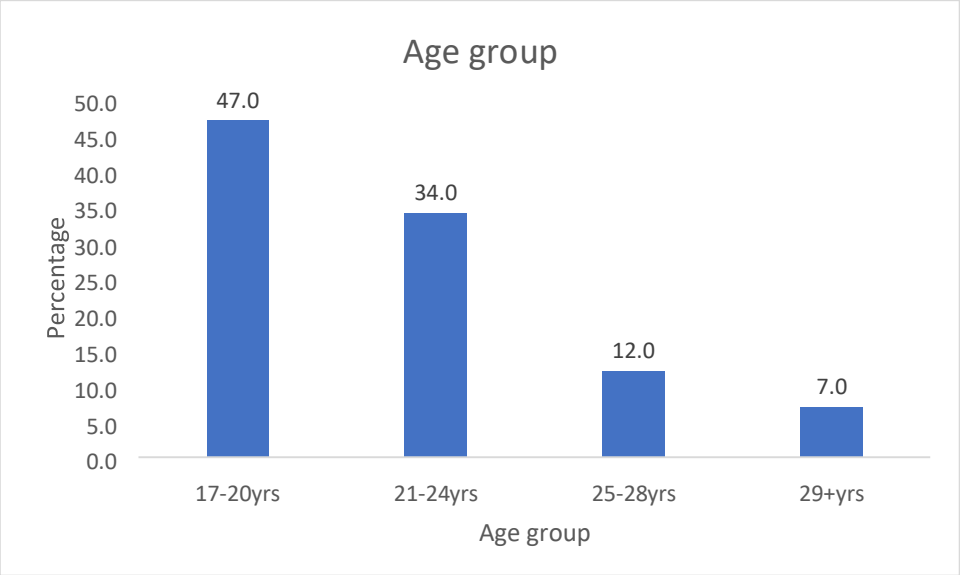

Figure 1: Age group of the undergraduate participants

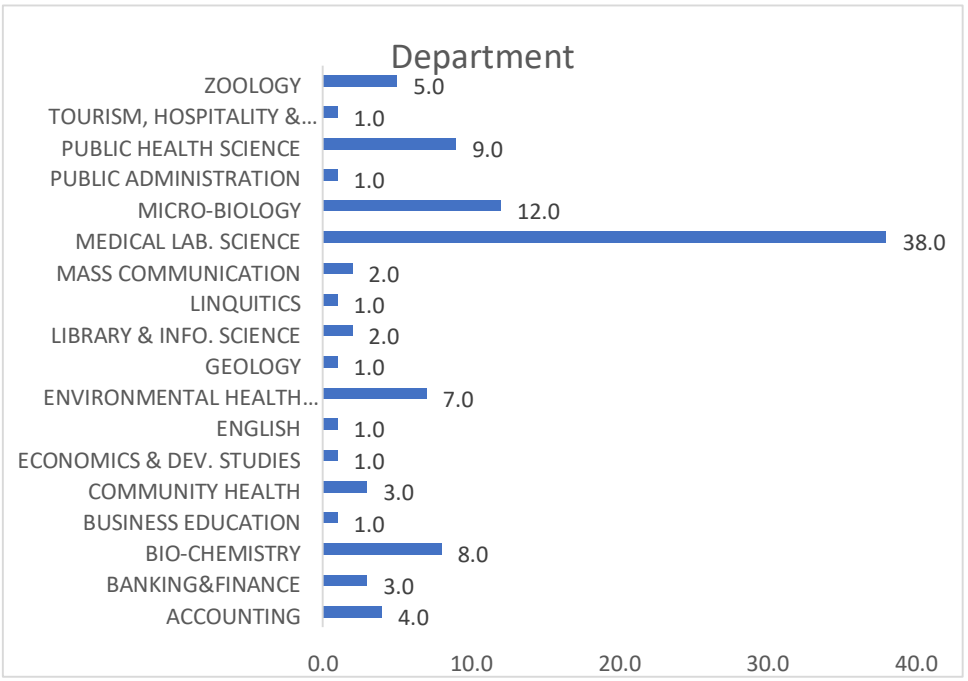

Figure 2: Departmental distribution of the female undergraduate students' participants.

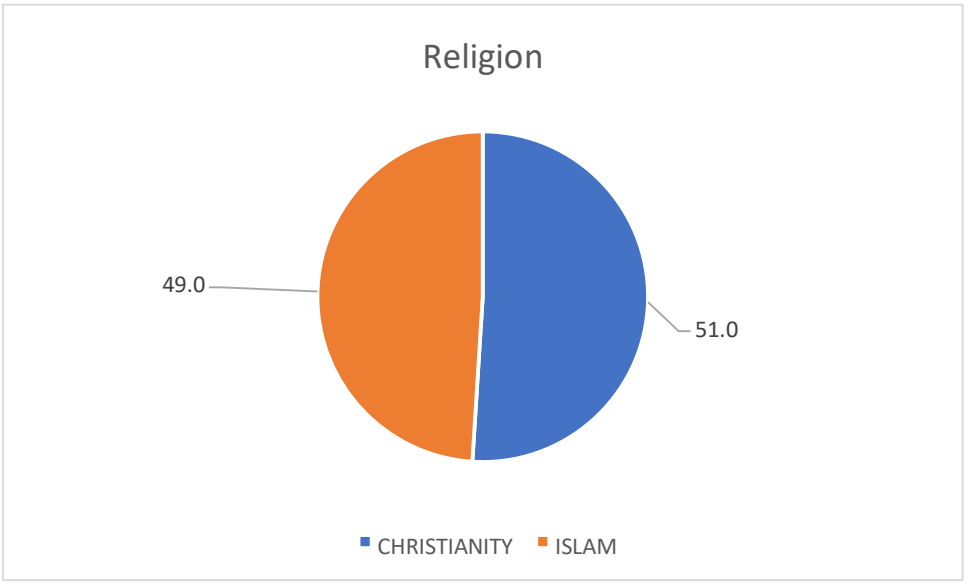

Figure 3: Religion denomination of the undergraduate Cosmetic Users.

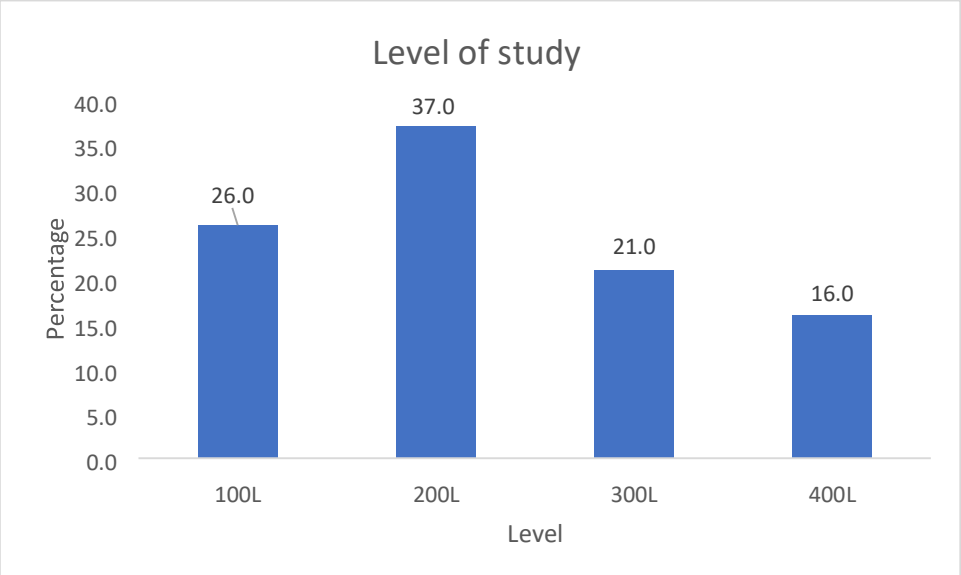

Figure 4: Class level of the undergraduate Cosmetic Users.

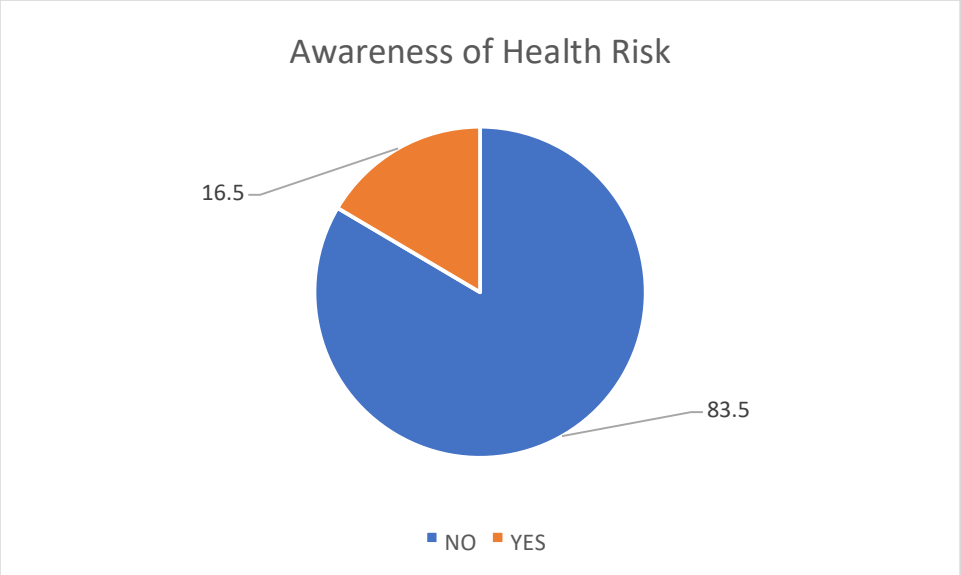

Figure 5. Health risk awareness of cosmetics among the participants.

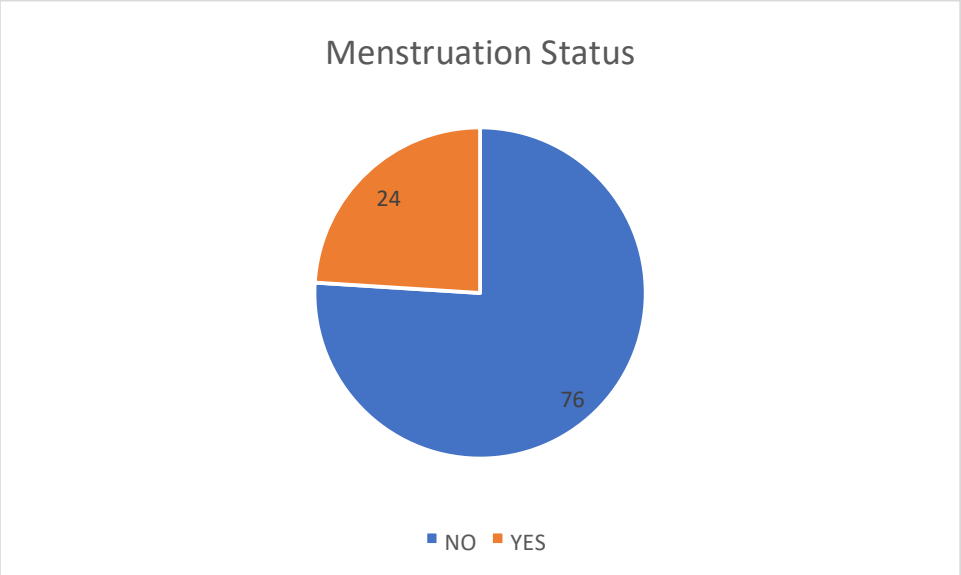

Figure 6. Menstrual status of the undergraduate cosmetic users.

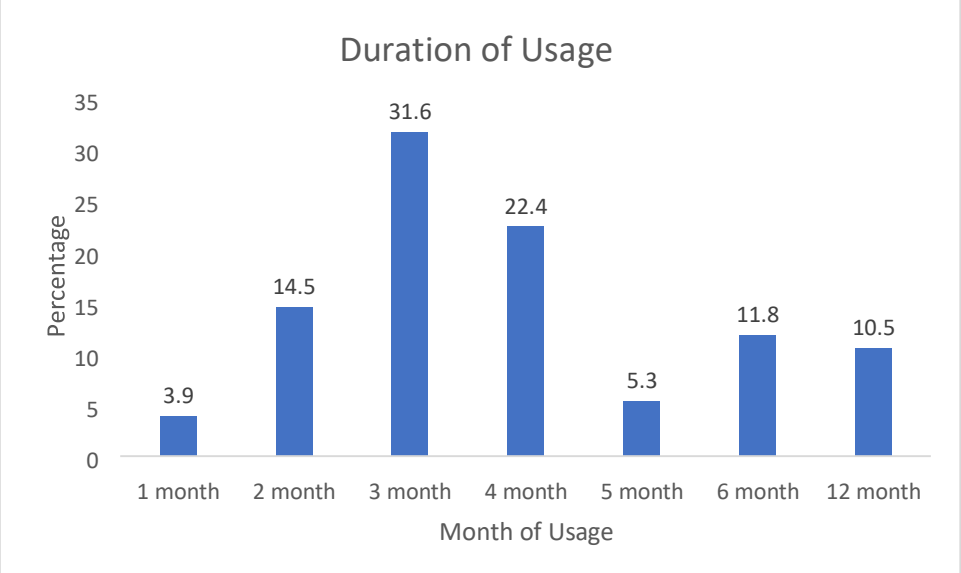

Figure 7. Duration of Cosmetic usage by the study participants

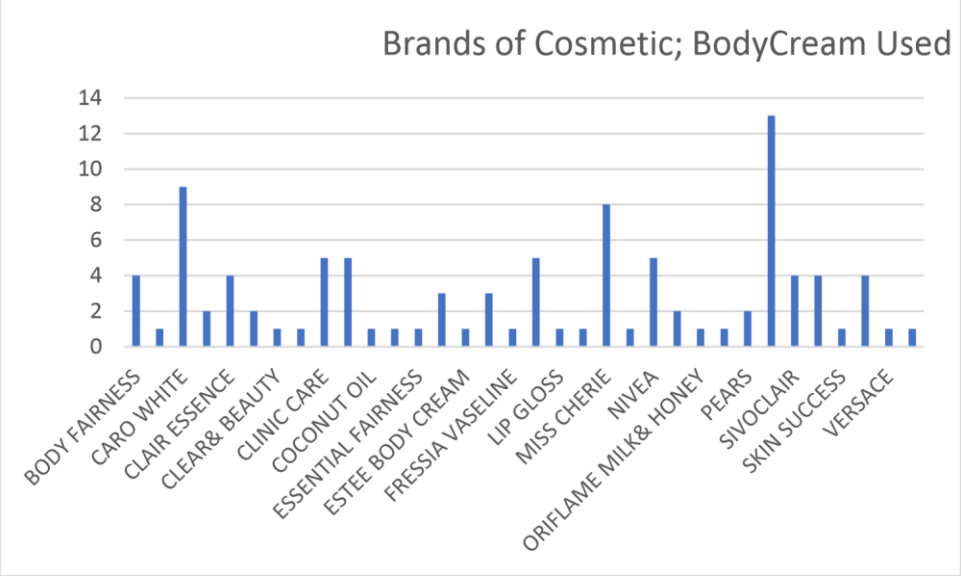

Figure 8: Brands of cosmetic (body cream) used by the undergraduate cosmetic user.

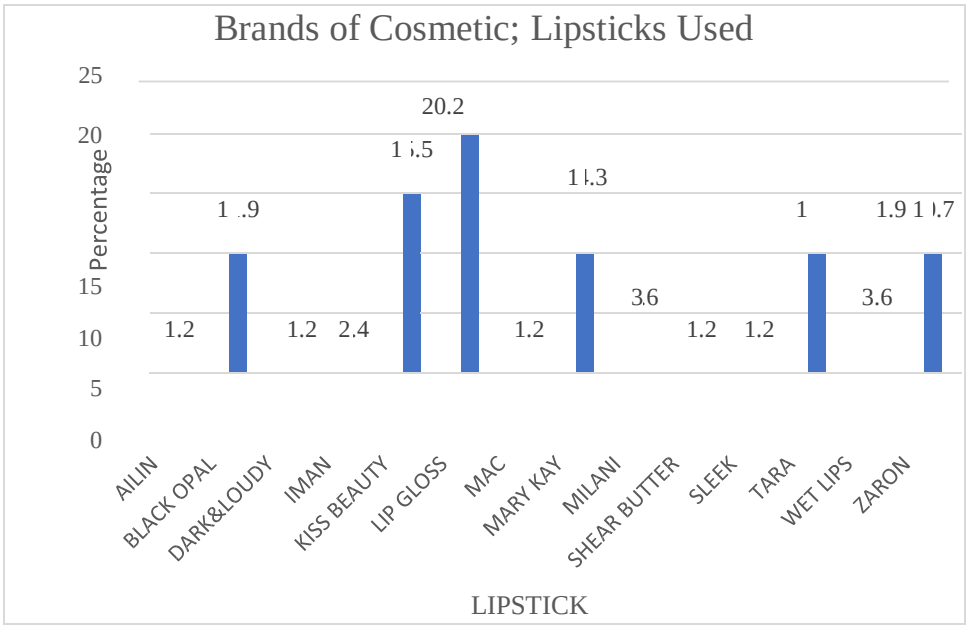

Figure 9. Brands of Cosmetic (Lipsticks) used by the study participants.