

Article

Assessment of the Knowledge, Attitude, and Practice of Sokoine University Students Regarding Endocrine Disruptors Coming from Plastic Chemicals

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Abstract:

Objective: The knowledge, attitudes, and practices of SUA students about the use of plastics containing endocrine disruptors were investigated in this study. **Methodology:** A study with 150 participants was conducted to assess individuals' knowledge about endocrine disruptors, attitudes, and plastic use practices. **Results:** The findings indicate that the participants possessed an average degree of knowledge 50.2 ± 3.85 with the main emphasis of awareness being generic concepts rather than specific substances. Regarding the potential health impacts of endocrine-disrupting chemicals present in plastics, respondents' attitudes ranged from fair to positive, with a mean score of 3.5 ± 0.09 indicating a fair attitude overall. Conclusion: It is important to practice polite behavior and increase public awareness of safe plastic disposal methods. Surprisingly only 38.0% of the participants mentioned that they refrain from heating their food in plastic containers to reduce their exposure to plastics. Students' practices revealed a notable dependence on plastic products despite their awareness of the concerns surrounding endocrine disruptors, as most of them reported using plastic water bottles, plastic cups, and plastic bags almost always. Additionally, only 20.7% of the respondents consistently implemented strategies to prevent exposure to endocrine-disrupting chemicals. **Recommendation:** The study recommended increasing the use of cleaner plastic substitutes and improving educational programs to convert information into practical actions. Policies that encourage environmentally friendly behavior and raise public awareness of safe plastic disposal techniques should be put into practice.

Keywords: Knowledge, Attitude, Practice, students, Endocrine Disrupting, Plastic Chemicals, SUA, Tanzania

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1. Introduction

A wide range of materials contain potential and known endocrine-disrupting chemicals (EDCs), the majority of which are man-made. These perturbors cause problems for human development, reproduction, brain function, and immune response by interfering with the body's endocrine system (Skakkebaek et al., 2011) [1]. In children, they also result in aberrant growth patterns and neurodevelopmental abnormalities. Diethylstilbestrol (DES), a non-steroidal estrogen associated with clear cell cancer in young women, is an illustration of their effects. Plastic bottles and metal food cans (BPA), medical equipment (phthalates), food (BPA), toys (BPA), detergents, flame retardants (polybrominated diphenyl ethers), cosmetics and medications (parabens), and insecticides (alkyl phenols, like nonylphenol) are all known sources of EDCs. Endocrine disruptors' detrimental impacts are a serious public health risk.

Bisphenol A (BPA) is an industrial chemical that has been used to create certain plastics and resins since the 1960s is one example of an EDC found in plastic compounds. It is present in polycarbonate plastics, which are frequently used in consumer goods like water bottles and other food and drink containers. It can also be found in epoxy resins, which are used to coat the interior of metal items like water supply pipes, bottle caps, and food cans. BPA may also be present in certain dental composites and sealants. Polybrominated diphenyl ethers (PBDEs) are an additional example.

According to Persson et al. (2022) [2], exposure to recognized EDCs is also rather high in contaminated ecosystems where industrial chemicals seep into the soil and water and are subsequently ingested by plants, algae, and microorganisms. Next, proceed to the animal kingdom, where larger creatures consume smaller ones and animals consume vegetation. These environmental compounds are found in the highest amounts in the tissues of animals at the top of the food chain, including humans.

Phthalate esters and bisphenol A are added as additives while plastic materials are being produced. But because of their propensity to leak out over time and in response to heat, they are now widely present as pollutants in the environment, even in the tissues of living things Zuccarello et al. (2019) [3]. In recent times, it has come to light that these substances have characteristics that cause endocrine system disruption, hence disrupting the functions of several hormones and exacerbating health problems in people. The actions of thyroid hormones, androgens, and estrogens are the main sources of reported disruptive effects. These effects raise concerns about potential negative effects on immune responses, thyroid function, metabolic processes, brain development and function, and the development of hormone-sensitive tissue cancers. Finding sensitive times of exposure throughout fetal development and the early postnatal period, which may subsequently result in chronic health problems, is a recurrent theme.

Gore et al. (2014) [4] shown that EDCs frequently cause disruptions to endocrine systems by either imitating or inhibiting a natural hormone. The EDC has the ability to mislead hormone receptors into believing that it is the hormone. This misfiring of the receptor can cause processes that are normally exclusively triggered by natural hormones to be engaged. Hormone blockers allow an EDC to attach to a hormone receptor; however, even in the presence of the natural hormone, the receptor is blocked and cannot be triggered.

The study aims to assess the knowledge gaps, prevalent attitudes, and existing behaviors related to endocrine disruptors from plastic chemicals among Sokoine University of Agriculture students in order to develop targeted educational interventions, awareness campaigns, and policy recommendations to mitigate the risks associated with EDCs.

2. Methodology

2.1. Research Design

This study employed a cross-sectional design, utilizing questionnaires for data collection. Both qualitative and quantitative data were gathered and subsequently analyzed.

2.2. Sampling Technique

The stratified random sampling method was applied, categorizing the student population of Sokoine University of Agriculture according to pertinent characteristics such as year of study and gender. The sample size was calculated using Fisher's formula: $\text{Sample size } (n) = \frac{Z^2 P (1-P)}{d^2}$ Where: n = Sample size Z = Z value at 95% confidence level, which is 1.96 P = Proportion of the population exhibiting the desired characteristic $Q = (1-P)$, representing the proportion of the population lacking the desired characteristic d^2 = Degree of precision.

2.3. Data Collection

The questionnaire was used to collect both qualitative and quantitative data. The questionnaire was developed with three domains, the first of which contained individual information such as sex, degree of education, and age.

The second domain was the individual's awareness of Endocrine Disruptors from Plastic Chemicals (EDCs).

The third area included a structured questionnaire with a mix of closed and open-ended questions focusing on the participants' attitudes and practices toward EDCs, with agree or disagree mutual indications.

3. Data analysis

The information gathered via the questionnaire was encoded to streamline the data entry process into Excel statistical software, enabling a summary of participants' overall trends in knowledge, attitudes, and practices. Mean scores were employed to assess the respondents' knowledge and attitudes, while frequency and percentage were utilized to present the results concerning practices related to endocrine disruptors from plastic chemicals.

4. Results

4.1. Socioeconomic characteristics of the respondents

The data presented in [Table 1](#) indicates that a significant portion 72.67% of the participants fell within the age range of 21 to 30 years, followed by those aged 31 to 40 years, 15 to 20 years, and those over 40 years. The gender distribution among the respondents was nearly balanced, with females constituting the majority at 51.3%. A large proportion 81.3% of the participants held a degree, while smaller percentages had attained a diploma 8.7%, a certificate 5.3%, a master's degree 4.0%, and a PhD 0.7%. In terms of relationship status, most respondents identified as single 62.0%, with others being in a relationship 28.7%, married 5.3%, or separated 4.0%. Concerning employment status, the majority 80.7% were students, while 15.3% were engaged in entrepreneurial activities, and 4.0% were employed. Among those who were either employed or entrepreneurs, a majority 60.9% reported having less than one year of work experience, while the remaining 39.1% had between one to five years of experience.

Table 1. Distribution of respondents based on their socioeconomic characteristics of the respondents

Demographic Information	Frequency	Percent
Age		
15-20	15	10.0
21-30	109	72.7
31-40	19	12.7
Above 40	7	4.7
Gender		
Male	73	48.7
Female	77	51.3
Level of Education		
Certificate	8	5.3
Diploma	13	8.7
Degree	122	81.3
Masters	6	4.0
PhD	1	0.7

Marital Status		
Married	8	5.3
Single	93	62.0
Separated	6	4.0
In a relationship	43	28.7
Occupational Status		
Employed	6	4.0
Involved in entrepreneurship	23	15.3
Only student	121	80.7
Years of Experience (if employed or in entrepreneurship)		
Less than 1 year	14	60.9
1-5 Years	9	39.1

4.2. The knowledge of Sokoine University of Agriculture students regarding the endocrine disruptors from plastic chemicals

In this research, a survey was conducted involving 150 students to assess their understanding of endocrine disruptors associated with plastics and their effects. Participants responded to various questions, with correct answers receiving a score of 100 and incorrect answers receiving a score of 0. The mean scores were categorized into three levels of knowledge: poor knowledge (0-40), average knowledge (41-70), and good knowledge (71-100). The results presented in Table 2 indicated that the overall knowledge of endocrine disruptors among the students was average, with varying levels of understanding based on the specific questions posed. Notably, students demonstrated good knowledge regarding the implications of endocrine disruptors on human health and the environment, achieving a score of (88.0±2.7). Conversely, their knowledge was poor in several areas, including the effects of endocrine disruptors on human health (34.0±3.9), the pathways through which these disruptors enter the human body (31.3±3.8), the identification of sources of endocrine disruptors beyond plastics (38.7±4.0), and strategies for reducing exposure to these substances (29.3±3.7). Additionally, students exhibited average knowledge in several domains: understanding the term "endocrine disruptors" (68.7±3.8), identifying common endocrine disruptors found in plastics (45.3±4.1), recognizing the long-term effects of exposure (47.3±4.1), understanding the impact on wildlife (58.0±4.0), awareness of existing measures to regulate endocrine disrupting chemicals (45.3±4.1), and differentiating endocrine disruptors from other chemical pollutants (66.0±3.9).

Table 2. The knowledge of students regarding endocrine disruptors from plastic chemicals

Question	Mean Score	Knowledge
What do you understand by the term "endocrine disruptors"?	68.67 ± 3.80	Average
Can you name endocrine disruptors commonly found in plastics?	45.33 ± 4.07	Average
How do endocrine disruptors affect human health?	34.00 ± 3.88	Poor
How do you think endocrine disruptors enter the human body?	31.33 ± 3.80	Poor
What are the potential long-term effects of exposure to endocrine disruptors?	47.33 ± 4.09	Average
How do endocrine disruptors impact wildlife and ecosystems?	58.00 ± 4.04	Average
Can you identify any sources of endocrine disruptors other than plastics?	38.67 ± 3.96	Poor
What regulatory measures exist to control the use of endocrine-disrupting chemicals?	45.33 ± 4.07	Average
How can individuals reduce their exposure to endocrine disruptors in their daily lives?	29.33 ± 3.73	Poor
Are endocrine disruptors solely a concern for human health, or do they also affect the environment?	88.00 ± 2.68	Good
How do endocrine disruptors differ from other types of chemical pollutants?	66.00 ± 3.88	Average
Overall knowledge	50.2 ± 3.85	Average

4.3. The attitudes of Sokoine University Agriculture students towards the use of plastic products containing endocrine disruptors

In this research, the attitudes of participants were assessed using a mean score system (0-2) indicating a negative attitude, (2.1-3.9) representing a fair attitude, and (4-5) represent a positive attitude, derived from responses to various questions on a five-point Likert scale. The overall attitude of the participants was classified as fair; however, responses varied from fair to positive across different questions. Participants exhibited a positive attitude towards several aspects, including the potential health impacts of plastic products containing endocrine-disrupting chemicals (mean score of 4.03 ± 0.12), the disclosure of such chemicals in plastic manufacturing (4.00 ± 0.11), willingness to pay a premium for certified plastic products free from endocrine disruptors (4.41 ± 0.13), and prioritizing the reduction of plastic products that contain these chemicals (4.20 ± 0.12). The remaining variables received a fair attitude score, as detailed in [Table 3](#) below.

Table 3. The attitude of students on the use of plastic products containing endocrine disruptors

Question	Mean score \pm SE	Attitude
How concerned are you about the potential health effects of using plastic products containing endocrine-disrupting chemicals?	4.03 ± 0.12	Positive
To what extent do you believe that exposure to endocrine disruptors from plastic products poses a risk to human health?	3.50 ± 0.10	Fair
Should manufacturers be required by law to disclose the presence of endocrine-disrupting chemicals in their plastic products?	4.00 ± 0.11	Positive
How frequently do you actively seek out plastic products labeled as "BPA-free" or "phthalate-free" when making purchasing decisions?	3.14 ± 0.09	Fair
How much confidence do you have in regulatory agencies to ensure the safety of plastic products in terms of endocrine disruptor content?	3.70 ± 0.10	Fair
How confident are you in your ability to identify plastic products that may contain endocrine-disrupting chemicals?	3.38 ± 0.09	Fair
To what extent do you believe that the potential health risks associated with using plastic products containing endocrine disruptors are communicated to the public?	3.62 ± 0.10	Fair
How wasing are you to pay a premium for plastic products that are certified to be free from endocrine-disrupting chemicals?	4.41 ± 0.13	Positive
How much influence do you believe individual consumer choices have on reducing the prevalence of plastic products containing endocrine disruptors in the market?	3.70 ± 0.10	Fair
How much priority do you believe should be given to reducing the use of plastic products containing endocrine disruptors in environmental and public health policies?	4.20 ± 0.12	Positive
Overall attitude	3.5 ± 0.09	Fair

4.4. The Practices of SUA students regarding the use of plastics containing endocrine disruptors

The results presented in [Figure 1](#) indicate that the most common usage patterns among respondents were always, frequently, occasionally, and rarely, respectively, for water plastic bottles and plastic cups. Plastic bags were the next most frequently used item, with respondents using them either frequently, occasionally, always, or rarely. Plastic packaging was the third most common item, with respondents using it either frequently, occasionally, always, or rarely. Plastic straws were the least commonly used item, with respondents using them either occasionally, rarely, always, or frequently. Plastic cutlery was also used less frequently, with respondents using it either occasionally, frequently,

rarely, or always. Plastic wraps were the most frequently used item, with respondents using them either frequently, occasionally, rarely, or always. Only a small number of respondents reported using other types of plastic materials, such as those found in cosmetics.

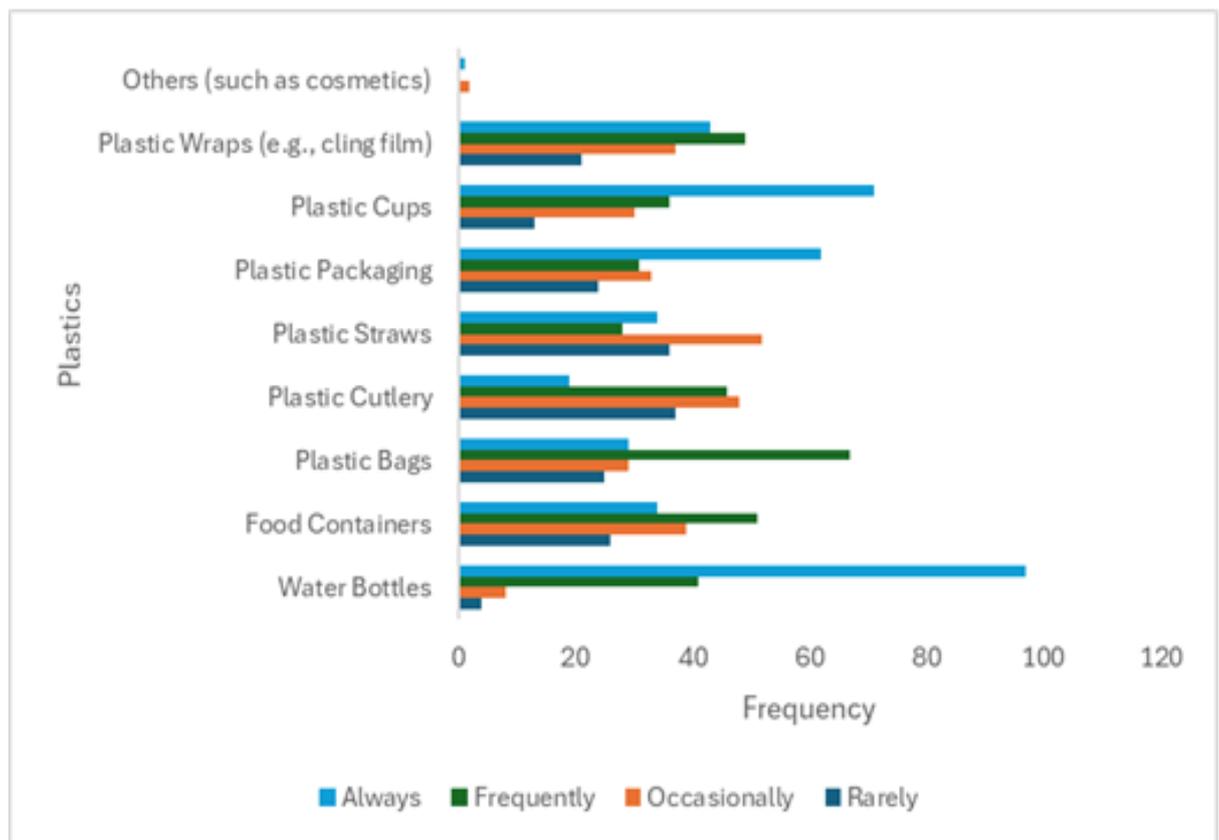


Figure 1. The usage of plastics among students at Sokoine University of Agriculture

In this research, the majority (57.3%) of the participants indicated that they are aware of the different types of plastics present in the items they buy. Among those who are mindful of the plastics in their purchases, the most common types mentioned were PVC (53.5%), PET (50.0%), PP (44.2%), HDPE (24.4%), LDPE (19.8%), and PS (15.1%). Less than 30.0% of the participants stated that they consistently try to avoid items that contain endocrine disrupting chemicals. The majority (38.0%) of the participants mentioned that they refrain from heating their food in plastic containers to reduce their exposure to plastics. Additionally, (18.0%) opt for glass or stainless steel containers over plastic, and (10.7%) check the labels of products for chemical ingredients. Only a quarter (25.0%) of the participants mentioned that they follow all three practices: using glass or stainless steel containers, avoiding heating food in plastic containers, and checking product labels for chemical ingredients. The majority (60.7%) of the participants have made the switch to products labeled as "BPA-free" or "phthalate-free", while a smaller percentage (39.3%) have not made this switch. When it comes to disposing of plastic items, the majority (62.0%) of the participants throw them in the trash once they are no longer needed, while (28.0%) recycle them, and (10.0%) are unsure of what to do with items they no longer need.

Table 4. The distribution of respondents based on their practices of SUA students regarding the use of plastics containing endocrine disruptors

Question	Response	Frequency	Percent
Are you conscious of the types of plastics used in products you purchase?	Yes	86	57.3
	No	64	42.7
If yes in qn 31, Please select all that apply.	PET (Polyethylene Terephthalate)	43	50.0
	HDPE (High-Density Polyethylene)	21	24.4
	PVC (Polyvinyl Chloride)	46	53.5
	LDPE (Low-Density Polyethylene)	17	19.8
	PP (Polypropylene)	38	44.2
	PS (Polystyrene)	13	15.1
Do you make an effort to avoid products containing endocrine-disrupting chemicals?	Yes, always	31	20.7
	Sometimes	96	64.0
	No, not usually	23	15.3
What steps, if any, do you take to limit your exposure to plastics and their associated chemicals?	Use glass or stainless steel containers instead of plastic	27	18.0
	Avoid heating food in plastic containers	57	38.0
	Read product labels for chemical ingredients	16	10.7
	All of the above	38	25.3
	None of the above	12	8.0
Have you ever switched to products labeled as "BPA-free" or "phthalate-free"?	Yes	91	60.7
	No	59	39.3
How do you dispose of plastic products once you no longer need them?	Recycle them	42	28.0
	Throw them in the trash	93	62.0
	Not sure	15	10.0

5. Discussion

The research revealed that participants generally had a moderate understanding of endocrine disruptors from plastic chemicals, suggesting a middle ground in their comprehension. Most participants showed a basic grasp of the concept, correctly identifying these substances as those that interfere with the endocrine system. On average, participants were familiar with the most common endocrine disruptors, indicating a lack of in-depth knowledge about specific ones like phthalates, polychlorinated biphenyls (PCBs), and bisphenol A (BPA). However, their understanding of the full spectrum of health effects linked to endocrine disruptors, including changes in hormone activity and increased cancer risks, was limited. These results align with a previous study by Heindel et al. (2017) [5], which highlighted that the general public's understanding of endocrine disruptors from plastic chemicals is often limited to basic ideas, with many lacking specific information about the chemicals and their impact on human health.

In contrast, research on particular professional groups, such as environmental scientists and healthcare professionals, showed a higher level of awareness about endocrine disruptors. The study by Diamanti-Kandarakis et al. (2009) [6] found that

experts, with their access to detailed research and specialized training, had a more thorough understanding. This difference points to the need for broader public health initiatives and educational programs to increase awareness. Moreover, students varied in their views on endocrine disruptors from plastic chemicals, ranging from fair to positive, with an overall sentiment of fairness. This sentiment was echoed by Hui et al. (2017) [7], who noted a fair attitude towards endocrine disruptors among participants and stressed the importance of targeted efforts to enhance knowledge and attitudes among students to reduce the negative health effects of endocrine disruptors. In this study, a significant number of students frequently used plastic water bottles, cups, bags, and packaging. This trend was also observed by Nguyen et al. (2022) [8], who reported a similar pattern of high usage of plastic water bottles, cups, and bags. Conversely, the use of plastic cutlery and straws was found to be rare. The widespread use of plastic wraps suggests a reliance on convenience despite growing health and environmental concerns. The widespread availability and convenience of plastic products seem to contribute to this excessive use. However, this widespread use of plastics also raises concerns about potential exposure to endocrine disruptors.

Rather than recycling, the respondent's primary method of waste disposal was tossing trash in the trash. Liu et al. (2021) [9] have made further observations about this in their study, which found that people in Vietnam did not frequently recycle plastic. The low recycling practices found in the current study may be related to inadequate recycling facilities or a lack of awareness about the effects of plastic trash on the environment. The majority of respondents have switched to "BPA-free" or "phthalate-free" products, which is an intriguing development that points to some degree of health-conscious consumer behavior. The results, however, show that students still do not know how to properly dispose of plastic, indicating that in order to promote sustainable behavior, infrastructure and instruction need to be improved.

6. Conclusion

The study offers a comprehensive understanding of the attitudes, knowledge, and behaviors of SUA students regarding the use of plastics containing endocrine disruptors. The respondents had a moderate level of knowledge; they were aware of the idea of endocrine disruptors and how they could affect health, but they lacked in-depth knowledge of the specific substances and their sources. Although they did not always act on this concern, the majority of respondents expressed some concern about the health risks linked to endocrine disruptors. Views on these drugs varied from neutral to favorable. Despite awareness of endocrine disruptors, behaviors indicated a high frequency of plastic use, particularly for cups and water bottles. Merely a minor proportion of individuals consistently acted to decrease their exposure to chemicals that disrupt hormones, indicating the disconnect between awareness and practical implementation.

7. Recommendation

To overcome the awareness gap and move toward action, it is recommended that SUA and similar institutions enhance their training programs to emphasize not only the identification of harmful plastics but also practical strategies for limiting exposure. If initiatives like seminars, workshops, and the incorporation of environmental health themes in the curriculum are put into place, students might behave more consistently and wisely. Programs that promote the use of safer alternatives to plastic, such as glass or stainless steel containers, should also be supported. It is also advisable to carry out additional research to look into the barriers preventing pupils from adopting safer practices. This made it possible to develop targeted interventions that inspired students to choose more wisely when it came to using plastic in their daily lives. Furthermore,

promoting recycling initiatives and increasing public awareness of proper disposal methods could help mitigate the damaging effects of plastic waste on the environment.

Conflicts of interest: The authors have not declared any conflict of interest.

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