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RESEARCH ARTICLE

Antecedents of sustainable e-waste disposal behavior: the moderating role of gender

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Abstract

This study presents an integrative sustainable e-waste model, drawing on organismic integration theory and gender schema theory. E-waste behavior has attracted considerable attention in the cleaner production literature in recent years. However, there is growing debate, and little research has been conducted in developing countries, especially Pakistan, to investigate the motivational factors influencing sustainable e-waste behavior. This study empirically examines the different effects of motivational (intrinsic, identified, introjected, and external) regulations on sustainable e-waste disposal behavior and identifies whether customer gender moderates these effects. To address this gap, we recruited 209 households, and structural equation modeling (SEM) and multi-group modeling (MGM) techniques were used to test the proposed hypotheses using AMOS. When assessing customers' habits and external, introjected, identified, and intrinsic motivations in terms of gender differences, the SEM results revealed that female has more motivational sentiments and compliance to social norms for disposing e-waste behavior. The MGM results revealed that the effect of intrinsic motivation on sustainable e-waste disposal behavior is important for male customers, while the impact of external motivation is important for female customers. Identified motivation appears to be a significant predictor both for male and female customers. Finally, we briefly discuss the study's implications for theory and practice and highlight priorities for future research.

Keywords Sustainable e-waste disposal behavior · Motivational regulations · Habit · Organismic integration theory · Gender schema theory

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Introduction

When electronic appliances are discarded after they become obsolete, and their residual life becomes zero, then the product becomes e-waste (Dias et al. 2019). E-waste appliances include computers, mobile phones, coffee machines, laptops, vacuum cleaners, dryers, toasters, VCR/DVD/CD players, refrigerators, and televisions that have been disposed of or discarded by the user at some point (Trivedi et al. 2020). E-waste can be defined as over-used and obsolete electronic products as a whole or in segments, from the production and repair process to an exhausted useful life destined for final disposal (Ranasinghe and Athapattu 2020). According to the Basel Action Network, most toxic waste is created by households in the form of personal computers, mobile phones and other electronic gadgets, monitors, telephones, and other household appliances, often referred to as "e-waste" (Sivaramanan 2013). E-waste comprises two components (chemical and physical, sometimes combined) that contain valuable but dangerous material that needs to be removed

by special recycling procedures to safeguard the environment from contamination that can detrimentally affect health conditions. E-waste is a major concern particularly among the youth (Borthakur and Govind 2018). Increasing in the residual life of electronic products depends on the country's economic growth, increasing population, market penetration, technological level, and the rates of obsolescence of different products (Kitila and Woldemikael 2019; Zhilyaev et al. 2021).

Notably, due to greater economic accessibility to new technological products, people are encouraged to buy new rather than repair obsolete equipment. Recycling, however, is a practice of converting worthless material into useful material. Therefore, the e-waste sector applies a recycling method that not only protects the environment from poisonous effects but also delays the exhaustion of crucial assets.

Estimates for the amount of e-waste being dumped annually by developed countries range from more than 50,000 tons (Dhir et al. 2021) to 95,400 tons (Ilyas et al. 2020). Qalati et al. (2021) recently reported that 74.2% of people globally have mobile phones. Furthermore, the purchase of televisions is expected to increase by 12% per year globally (mainly due to the rapid evolution of advanced technology), while sales of personal computers are also rising by 5.8% per year (due to the growing needs of individuals, businesses, and public sectors) (Park et al. 2013). The general drivers for purchasing Integrated Acquisition System (IAS) are the growing population and rapid urbanization, while the main elements behind increasing e-waste are technologies that attract people to purchase new products in the market (Dhir et al. 2021). In addition, the local gray market for second-hand goods also plays a role, making it difficult to quantify the production of e-waste in a country. In this context, Rahman et al. (2020) recently reported that most developing countries, including Pakistan, do not have any specific e-waste legislation. In addition, e-products have been central to the discussion of resource sustainability because of the gradual increase in demand, the utilization of resources, and significant issues in managing e-waste (Parajuly et al. 2020). Thus, to tackle the alarming increase in e-products and e-waste, end-users' behavior towards e-waste needs to be thoroughly studied (Islam et al. 2021a, b). Furthermore, to foster e-waste recycling, it has been argued that the factors affecting households' behavior towards the recycling of e-waste need to be explored and that the extent to which these factors influence males' and females' behavior need to be identified (Islam et al. 2021a, b; Otto et al. 2018). Thi Thu Nguyen et al. (2019) have also argued that household users play a key role in managing e-waste. However, very few studies have focused on the public perception of e-waste recycling.

As well as examining what motivates consumers to consider e-waste, the present study also examines the moderating role of gender. Practitioners usually study gender differences in terms of market segmentation (Gallego-Álvarez and Pucheta-Martínez 2020; Qu et al. 2019; Thi Thu Nguyen et al. 2019); accordingly, market segment is used in the present study as a key moderator. The present study, therefore, attempts to identify the antecedents of sustainable e-waste disposal and examine how motivational regulations on consumers' e-waste behavior can be affected by gender differences.

There are various gender differences in the behavior of males and females in relation to e-waste disposal. The disposing behavior depends on different circumstances related to the region and the facilities available. For instance, Wang et al. (2016), using a sample of seven geographic regions and 22 provinces in China, found that e-waste disposal behavior among consumers depends on the level of environmental awareness, attitudes towards recycling, perceptions of informal recycling, income and the cost of recycling, norms, and publicity. Moreover, consumers' attitudes towards electronic equipment e-waste rely on individual decision-making about the recycling of e-waste. Consumers' awareness, self-efficacy, social norms, and intention to recycle determine consumers' willingness to dispose e-waste responsibly. Another study has suggested that demographic or socio-economic factors, such as age, gender, income, education, and number of family members, determine individuals' e-waste behavior; the inconvenience of recycling was also shown to have an undesirable effect on consumers' e-waste disposal behavior (Thi Thu Nguyen et al. 2019). In addition, environmental motivation and behavioral costs modify individuals' e-waste behavior (Otto et al. 2018). Furthermore, cultural effects vary from country to country (Delcea et al. 2020).

Another study was conducted in Italy from 2008 to 2015, in which e-waste disposal behavior was evaluated based on age, gender, household size, education level, migration, and income. The results showed that household waste collection and the percentage of females in the household were positively correlated (Favot and Grassetti 2017).

In Pakistan, there is a difference between the disposal behavior of males and females due to their gender differences, awareness and education level, income, socio-economic differences, and cultural influences. Such factors strongly affect males' and females' disposal behavior in the present study's results, where the ratio of females to males is comparatively high. Rapid economic growth and overconsumption have affected the environment in Pakistan. This has raised ecological consumption issues whereby gender-based disposal behavior is affected by functional, social, epistemic, emotional, and conditional values. Religious values have also been shown to influence the gender-based e-waste disposal behavior (Ali et al. 2019).

The present study on sustainable e-waste disposal behavior contributes to the literature in two ways. First,

motivational regulations are associated with the conduct of consumers regarding the disposal of e-waste while considering the effects of external, introjected, identified, and intrinsic motivations. Second, gender differences are explored that have an impact on attitudes toward e-waste disposal behavior. These two contributions can help marketing firms and brand managers design and implement suitable strategies for attracting both male and female customers.

Literature review

Theoretical background

Much of the organism integration theory and research have classified individual topics in several areas of life, including the workplace (Gilal et al. 2020), academia (Fortier et al. 1995), romantic relationships (Blais et al. 1990), and sport and gymnastics (Standage and Ryan 2020), as well as the linkage between regulation and motivations regarding sustainable e-waste disposal behavior. However, to the best of the authors' knowledge, the relationships among the different kinds of motivational factors (intrinsic, identified, introjected, and external) and the effects on sustainable e-waste disposal behavior have been rarely addressed in the marketing sector. E-waste is an important issue worldwide. According to the Organization for Electronic Cooperation and Development (OECD), e-waste has no specific definition: Any device that uses an electricity source that has consumed its useful life is called e-waste. Rapid economic and urban development has dramatically increased the consumption of electronic products, leading to a massive quantity of e-waste worldwide.

The United Nations recently warned that e-waste from products such as laptops and cell phones is growing worldwide and has called for the improved recycling of often hazardous waste. In 2016, 44.7 million tons of e-waste were generated worldwide, representing an alarming increase of 8% of the Telecommunication Union (UNU) and the International Association of Solid Waste (Hsu et al. 2019). This is the equivalent of 4500 Eiffel Towers, and this figure is expected to increase significantly in the coming decades. By 2021, the world will likely be producing 52.2 million tons of e-waste annually, which today mainly comes from refrigerators, washing machines, and other household appliances, as well as an increasing number of mobile phones and computers. Such waste can pose a severe risk to the environment and human well-being, although it is currently rarely recycled or disposed of properly, mostly ending up in landfills (Behrens 2013).

Organismic integration theory

OIT is a theory of psychology that explains that behavior is regulated by two means: internal structures; and experiences. Here, both the internal and external environment play a role in the regulation of behavior (Deci and Ryan 1985).

In a social context, self-determination theory (Ryan and Deci 2020) uses organismic integration theory to distinguish individuals' regulatory processes based on the level of self-determination (Ryan and Deci 2020). Self-determination theory is a human motivation and personality theory that distinguishes between autonomous and controlled motivation. It also works on intrinsic and extrinsic motivation (Deci and Ryan 2012).

Gender schema theory

GST is a theory of psychology in which masculine or feminine traits are acquired; when an individual reaches the age of four of five, they start adopting gender-specific traits as per their culture. GST focuses on preferences, skills, personality characteristics, behaviors, and self-concepts, as per their designated culture (Bem 1983). This theory, developed by Sandra Lipsitz Bem (a US-based psychologist), can be used to analyze development, discrimination/stereotyping occupations, historically marginalized populations, and mental health and trauma (Starr and Zurbriggen 2017). GST also explains gender-based schematic processes in which the readiness of information processes in different genders is evaluated. This theory furthers the argument that self-concept regarding gender roles is integrated into gender schemas. Such gender schemas are derived from social and cultural interferences (Bem 1981). In addition, GST elucidates the development and significance of sex typing, which is a way of attaining sex-based traits, such as preferences, skills, personality traits, behaviors, and self-concepts that are related to gender. Furthermore, this theory provides insights into gender-based mental development at an early age, which becomes a basis for the inspiration of attention, motivation, person perception, impression formation, and behavior. These gender schemas are triggered by situations as well as by culture (Freedman 1992).

In addition, four different kinds of motivation (intrinsic, introjected, identified, and extrinsic), which from part of a continuum, are studied. Intrinsic motivation, which falls in a continuum extending from extrinsic motivation to intrinsic motivation, reflects an exclusive behavior that is for one's good, or for the enjoyment of the individual. For example, an individual may be inspired to dispose of e-waste, in line with his/her wishes, because of her/his intrinsic interest in e-waste. Identified motivation concerns identifying consumers related to the personal credit assigned to their use of a product/service. For example, a consumer may be pushed by

dispose of electronic products by taking care of the environment and not being damaged by society in return. Introjected motivation is demonstrated when the individual avoids feelings of guilt, shame, or anxiety, or increases his/her pride or ego. For instance, a person may be encouraged to dispose of e-waste to avoid being blamed and embarrassed if other individuals are already demonstrating a positive behavior towards e-waste. Finally, external motivation is related to external gains, such as rewards or power. For example, an individual may be willing to dispose of e-waste to maintain social pride and status, i.e., make an already important person feel happy and contented when protecting the environment. Self-determination theory elaborates on various variables that inspire consumers to take action (Ryan and Deci 2020). An individual may choose electronic products either due to her/his interest in new or smart electronic products or in order to show his/her financial power to boost social status in her/his class. Self-determination theory has also categorized two kinds of motivations: intrinsic and extrinsic (Ryan and Deci 2020). Intrinsically, motivated behaviors originate from behavior that appeals to interests and/or pleasures in and of themselves, while extrinsically motivated behaviors are driven by achieving an objective that is external to the behavior itself.

Hypotheses development

Intrinsic motivation and sustainable e-waste disposal behavior

Dhir et al.'s (2021) study found conflicting evidence of the effect of intrinsic motivation on sustainable e-waste disposal behavior. Several academic marketers have indicated the impacts of intrinsic motivation on e-waste disposal. Examining the relationship between intrinsic motivation and sustainable e-waste disposal behavior, Affordofe and Quansah (2021) found that customers' e-waste preferences are adversely affected by intrinsic motivation, tending to lead to incorrect behavior. This finding was supported in a recent study by Razmus and Laguna (2019), revealing that aspects of intrinsic motivation, such as self-acceptance, affiliation, and community feelings, are negatively related to e-waste disposal behavior as part of one's self-concept. In contrast, some other academicians have found a positive relationship between intrinsic motivation and sustainable e-waste disposal behavior (Wang et al. 2019). For instance, Gilal et al. (2019) adopted a self-determination approach to reveal the effects of intrinsic motivation on e-waste disposal behavior, while Bell and Deubzer (2018) demonstrated that intrinsic motivation is central to e-waste disposal in the context of environmental safety. In line with these results and with OIT and self-determination theory, the present study thus hypothesizes:

H1. Intrinsic motivation is positively associated with sustainable e-waste disposal behavior.

Identified motivation and sustainable e-waste disposal behavior

The second hypothesis concerns the relationship between identified motivation and sustainable e-waste disposal behavior, which has not been tested in previous studies in the context of e-waste disposal. OIT suggests that people with personal preferences tend to adapt their behavior regarding the disposal of e-waste (Ryan and Deci 2020). For example, an individual must be willing to adapt her/his behavior to eliminate waste if he/she identifies himself/herself with the importance of properly disposing of e-waste. This has been demonstrated by Liu and Chiang (2019), who found a positive relationship between identified motivation and e-waste disposal behavior, suggesting that people tend to adopt e-waste disposal based on their personal values. In line with such empirical results and OIT's theoretical underpinnings, the present research also hypothesizes a positive link between identified motivation and e-waste disposal behavior:

H2. Identified motivation is positively associated with sustainable e-waste disposal behavior.

Introjected motivation and sustainable e-waste disposal behavior

The third hypothesis evaluates the link between introjected motivation and e-waste disposal behavior. As previously discussed, OIT postulates that people with introjected motivations are driven to participate in an activity to save face/avoid the emotional state of shame and maintain self-esteem (Gagné et al. 2018). For example, a young individual may dispose of e-waste to save face and strengthen his/her pride if his/her friends have already started adopting such behavior (Nguyen and Watanabe 2020). This theoretical understanding has been tested empirically. For example, White (2015) conducted an empirical study regarding a specific electronic product and reported that introjected motivation is a significant factor in relation to e-waste and positive emotions in the initial phase, whereas Liu and Chiang (2019) found a significant impact of such motivation within families regarding e-waste. These conflicting individual- and family-based arguments have led to inquiry into whether the interpretation of motivation can be decoded and translated into the context of e-waste. Therefore, the present study aims to examine whether introjected motivation significantly improves e-waste disposal adoption through the following hypothesis:

H3. Introjected motivation is positively associated with sustainable e-waste disposal behavior.

External motivation and sustainable e-waste disposal behavior

The fourth hypothesis is related to the influence of external motivation on consumers' sustainable e-waste disposal behavior. OIT postulates that extrinsic motivation, based on peer pressure and social status, is a potent motivator of consumers' e-waste disposal behavior (Gagné et al. 2018). Such consumers use electronic products and intend to reuse them, via resale or sending them to a manufacturing company so they can be recycled. Some signs of societal improvement in relation to an increment in the value in the eyes of society have been found (Wang et al. 2018). Gilal et al. (2019) discovered that customers' e-waste disposal behavior is positively affected by external motivation and that consumers have a tendency to adopt sustainable e-waste disposal behavior in a manner consistent with how they would like others to perceive it. Furthermore, Razmus and Laguna (2019) observed that, in order for self-concept in social life to meet external ambitions, consumers show a greater tendency to dispose of e-waste responsibly. Following these studies and OIT, the present study proposes that there is a relationship between external motivation and consumers' e-waste disposal behavior:

H4. External motivation is positively related to e-waste disposal behavior.

Habit and sustainable e-waste disposal behavior

A habit is defined as a learned and goal-oriented response that is maintained in certain circumstances. Aboelmaged (2021) stated that e-waste intentions include a sequence of routine behaviors, including sorting, segregating, moving, cleaning, reusing, returning, dissembling, selling, or upgrading all types of e-waste (e.g., notebooks, cell phones, CDV/VCR/tape recorders, digital cameras, laptops). These connected activities can best be designated as repetitive or habitual patterns, where there is a propensity for a person to do them without much critical analysis. In addition, habit plays a significant role in the disposing of e-waste (Aboelmaged 2021) because habit is an outcome of unconsciously repeated behavior (Chen et al. 2020). Moreover, habit is shaped through past experiences (Aydin and Yildirim 2021). For example, an individual may have developed a habit for sustainable e-waste disposal behavior in the past, making it likely that, in the future, the same sustainable e-waste disposal behavior is only undertaken out of habit. A recycling habit is one of the key factors regarding willingness and behavior in relation to e-waste recycling (Wang et al. 2011). Furthermore, Aboelmaged (2021) recently studied sample of 379 individuals from the UAE and evidenced a positive influence of e-waste recycling habits on young consumers' intentions. Furthermore, this author called for future studies in the developing countries context. Thus, we hypothesize:

H5. Habit is positively related to e-waste disposal behavior.

Moderating effect of gender

In the context of information technology, Taherdoost (2019) and Liao (2018) have asserted that the usefulness of brand-new electronic technology is perceived less by women than by men. This has been evidenced by Marinković et al. (2020) in the context of mobile chat services, with men's perceived utility rating being higher than that of women. Empirical research has also shown that women are more intrinsically motivated to avoid ground-breaking electronic goods owing to less perceived pleasure (Esteves et al. 2021). Furthermore, Ko et al. (2019) found that women, compared to men, are less inclined towards e-waste disposal, while Blake (2018) suggested that women are more interpersonally orientated and influenced by social image than men.

In the present study, there are more male than female respondents; this is due to several reasons in the context of Pakistan. A similar ratio has also been observed in other studies (Islam et al. 2021a, b; Saud 2020; Shaikh et al. 2020). In addition, a majority (60%) of the entire population is under the age of 25 years (Saud, 2020). E-waste is a major environmental issue based on improper disposal. Disposal behavior also differs between males and females due to the availability of knowledge to each gender. For example, Liang and Sharp (2016) study, conducted in China, Laos, and Thailand, found that gender was positively correlated with environmental knowledge and that females were less informed than males in the context of e-waste disposal.

Mobile phones represent a technology with a short life cycle (approximately 1 year), and e-waste from this technology is increasing. In this context, Ongondo and Williams (2011) conducted a study among UK and US university students, finding that 60% of phones that were replaced were not sent for recycling or disposed of, being kept instead as backup phones. Males were found to be more likely to keep old, backup mobile phones than females. E-waste disposal behavior among students was rarely observed, suggesting the need for further awareness of e-waste disposal behavior.

In contrast, however, a study conducted in Hong Kong found that females were more serious about environmental issues (lee, 2009). Multi-staged random sampling was performed, resulting in 2975 male and 3035 female

respondents. The results showed the females were more likely to use green products. Although females had higher environmental concerns, males had a higher score related to self-identity in the context of environmental protection.

Such variation in gender differences has also been observed in an Egyptian study (Mostafa 2007). The findings were analyzed using multivariate analysis of variance (MANOVA), which revealed gender differences in green purchasing and e-waste behavior. In addition, women were less conscious of environmental issues than men. Grounded on these pragmatic proofs and GST, the intrinsic and introjected motivations for women are considered to be greater than for men. Furthermore, the recognized and extrinsic motivations for adopting e-waste disposal behavior are of greater importance to men than to women. Accordingly, we hypothesize:

H6. The effects of (a) intrinsic and (b) identified motivation on sustainable e-waste disposal behaviors are more important for females than for their male counterparts, and the effect of (c) introjected and (d) external motivation on sustainable e-waste disposal behavior is more important for males than for females.

Research methodology

Research context

This research is undertaken from the perspective of Pakistan to determine people's e-waste disposal behavior. The choice of Pakistan is motivated by three reasons. First, Pakistan is the sixth most populous nation in the world, predicted to become fourth by 2050 (Mussadaq 2011). Importantly, it is a third-world country with poor infrastructure and a corrupt economy; most citizens have low accessibility to the purchase of new electronic products, but second-hand products are widely purchased. Therefore, the demand for cheap and used products is higher in this market. Second, Pakistan is unable to create an inventory of domestically generated e-waste as this has been overlooked by government agencies and law-making organizations. Third, according to Carraher's (2003) cultural typology, Pakistan is a collectivist nation, in which individuals create collective communities that show a robust attitude toward self-presentation. They choose electronic/technological products to showcase wealth and status and to symbolize their social well-being (Juan Li and Su 2007). Therefore, there is a need for a robust model to explain the basis for customer segmentation and positioning strategies in developing countries such as Pakistan.

Participants and data collection

The data were collected using a random sampling of selected families between September 2019 and April 2020. Participants ($n = 209$) comprised young and older adults, from different backgrounds, to whom questionnaire forms were sent for the purpose of data collection. The data were obtained from the main cities of Pakistan (Karachi, Sukkur, Larkana, and Naushehro Feroze). The participants were deliberately sampled from these cities to reduce regional differences in the present study. Table 1 presents participants' demographic information.

Procedure

The data were collected through self-administered questionnaires. The participants were initially asked to participate in a short survey on consumer behavior. Subsequently, they were given a questionnaire and a cover letter to help them understand the scale properly. After being given the questionnaire, participants were instructed to think of any electronic product they owned, and whether they would like to demonstrate sustainable e-waste disposal behavior. They were also requested to consider various e-waste products, e.g., old computers, mobile phones, coffee machines, laptops, VCR/DVD/CD players, vacuum cleaners, dryers, toasters, refrigerators, and televisions.

Table 1 Respondents' demographic profile

Criterion	Characteristics	Percentage
Age (years)	18–24	34.9
	25–34	51.2
	35–55	13.4
	> 55	0.5
Gender	Male	60.3
	Female	39.7
Education	Bachelor's	25.8
	Master's	22.0
	MS/Phil	48.3
	Others	3.8
Marriage	Single	51.2
	Married	48.8
Occupation	Student	34.8
	Own business	19.8
	Government employee	33.3
	Private employee	12.1
Income (PKR)	10,000–20,000	24.9
	20,000–40,000	14.1
	40,000–60,000	28.8
	Above 60,000	32.2

$n = 209$ (sample size)

Next, they were asked to spend 10 min completing the survey, which mapped the dependent (sustainable e-waste disposal behavior), independent (intrinsic, identified, introjected, and external motivation, and habit), and moderating (gender) variables.

Measures

The original scales for the above variables were presented to five experts to check the items' content validity and further refine the items. We then conducted a pilot/pretest with a sample of 40 families residing in the main cities of Pakistan to confirm that respondents clearly understood all the scale items. Habit related to sustainable e-waste disposal behavior was measured using three elements adopted from Gilal et al. (2019). Intrinsic, identified, introjected, and external motivational were measured using a 12-item scale (Goudas and Biddle 1994; Standage et al. 2005). Sustainable e-waste disposal behavior was measured using six items adopted from Gilal et al. (2019). All responses were reported on a five-point Likert-type scale (1 = "Strongly disagree" to 5 = "Strongly agree"); the Cronbach's alpha value for each scale was above the 0.70 threshold (Hair et al. 1998). Finally, the gender of each respondent was operationalized as "Male" = 1 (i.e., male customer) and "Female" = 2 (i.e., female customer), following Gilal et al. (2019).

Data analysis and software

Exploratory factor analysis (EFA), confirmatory factor analysis (CFA), correlation, and a moderation analysis were used as methods to measure the hypothesized associations among variables, using both SPSS 24.0 and AMOS 24.0

Results

Explanatory factor *analysis*

The EFA analysis was applied using SPSS 24.0 before testing the hypotheses to verify the applicability/appropriateness of each indicator from Pakistan's perspective. The outcomes of the EFA are summarized in Table 2, revealing six-factor solutions with given values greater than 1.00. All the communalities were greater than the threshold of 0.60 (Weaver and Maxwell 2014), and the items were loaded onto the respective factor. Moreover, the value for the Kaiser–Meyer–Olkin (KMO) test was greater than the threshold of 0.70, and Bartlett's test of sphericity was significant at $p < 0.001$, suggesting a good fit (Weaver and Maxwell 2014).

Confirmatory factor analysis

CFA was then performed to assess the reliability of measuring the variables with the latent variables constructed from the hypotheses. The CFA revealed 16 elements for intrinsic

Table 2 Exploratory factor analysis for the six-factor model

Items	Introjection	Intrinsic	External	EWDB	Identified	Habit	Mean	SD	Skewness	Kurtosis
Introjection-3	0.829						3.674	1.319	−0.803	–0.425
Introjection-1	0.819						3.435	1.396	−0.374	−1.145
Introjection-2	0.818						3.751	1.261	−0.913	−0.066
Intrinsic-3		0.843					3.430	1.269	−0.426	−0.774
Intrinsic-2		0.807					3.540	1.251	−0.502	−0.706
Intrinsic-1		0.804					3.464	1.188	−0.373	−0.732
External-2			0.839				3.526	1.355	−0.518	−0.932
External-1			0.803				3.693	1.185	−0.627	−0.425
External-3			0.791				3.622	1.280	−0.608	−0.702
EWDB-6				0.798			3.478	1.105	−0.538	−0.258
EWDB-5				0.796			3.550	0.950	−0.383	−0.396
EWDB-4				0.790			3.421	0.997	−0.367	−0.226
Identified-1					0.866		3.569	1.007	−0.505	0.087
Identified-2					0.797		3.445	1.086	−0.436	−0.360
Habit-2						0.832	3.703	1.041	−1.005	0.598
Habit-1						0.821	3.674	1.078	−0.924	0.299
% of variance	15.282	15.183	15.031	14.400	10.585	10.307				
Cumulative % of variance	15.282	30.465	45.496	59.895	70.480	80.787				

KMO measure of sampling adequacy = 0.861; Bartlett's test of sphericity = 1969.324, $p < 0.001$

motivation, introjected motivation, identified motivation, extrinsic motivation, and habit. A model of the sustainable e-waste disposal behavior factors revealed good adaptation values.

Structural equation modeling

Next, the maximum likelihood method in SEM was used to test the hypotheses; Table 3 and Fig. 1 show the outcomes of the operational model. The proposed structural model showed values for the comparative adjustment index (CFI) of 0.940, the Tucker-Lewis index (TLI) of 0.919, PLCOSE of 0.091, and the Akaike information criterion (AIC) of 494.568. *H1* posited that intrinsic motivation is positively associated with sustainable e-waste disposal behavior, while the results were found to be non-significant. *H2* posited that identified motivation is positively associated with sustainable e-waste disposal behavior, and results also show a significant influence on sustainable e-waste disposal behavior. As per the proposed hypothesis, the results are matched ($\beta = 0.44$***, $p =$ NS). *H3* postulated that introjected motivation is positively related with sustainable e-waste disposal behavior, but in hypothesis testing only a negligible effect on sustainable e-waste disposal behavior was found ($\beta = 0.003$, $p =$ NS). *H4* postulated that external motivation is positively associated with sustainable e-waste disposal behavior, after running the data, the results did not demonstrate the significance of this ($\beta = 0.103$, $p =$ NS). *H5* posited that habit is insignificantly associated with sustainable e-waste disposal behavior; ($\beta = 0.150$, $p =$ NS). Similarly, the moderating role of gender was examined in measuring the effects of intrinsic and introjected motivation on sustainable e-waste disposal behavior, with results showing that the moderating relationship is weaker for men than for women, while the results revealed that identified and external motivation for sustainable e-waste disposal behavior is weaker for women than for men ($\beta = 0.39$, $p < 0.05$).

Moderating effects: multi-group modeling

To explore the moderating effect of gender on sustainable e-waste disposal, the multi-group SEM was estimated using AMOS 24.0. Our results presented in Table 4 for *H6* show that the relationship between diverse motivations and

Table 3 Overall structural equation modeling results

Hypothesis	Proposed relationship	Standardized beta	*t*-value
H1	Intrinsic motivation → sustainable e-waste disposal behavior	0.180	1.730 ns
H2	Identified motivation → sustainable e-waste disposal behavior	0.439***	4.548
H3	Introjected motivation → sustainable e-waste disposal behavior	0.003	0.029 ns
H4	External motivation → sustainable e-waste disposal behavior	0.103	0.943 ns
H5	Habit → sustainable e-waste disposal behavior	0.150	1.421 ns

***$p < 0.001$

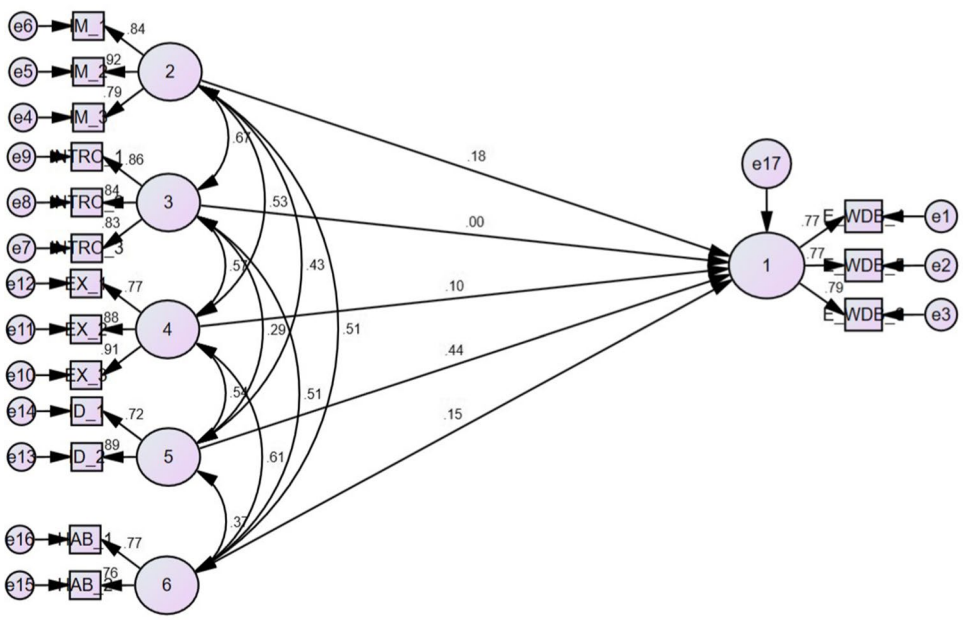

Fig. 1 Testing direct hypotheses without moderation

Table 4 Results of multi-group analysis for two sub-samples

Relationship	β (t-value) Males	β (t-value) Females
Intrinsic motivation → Sustainable e-waste disposal behavior	0.42** (2.48)	−0.03 (−0.199) ns
Identified motivation → Sustainable e-waste disposal behavior	0.44*** (3.07)	0.35*** (2.771)
Introjected motivation → Sustainable e-waste disposal behavior	−0.09 (−0.599) ns	0.09 (0.695) ns
External motivation → Sustainable e-waste disposal behavior	−0.05 (−0.369) ns	0.34* (2.228)
Habit → Sustainable e-waste disposal behavior	0.15 (1.122) ns	0.1 (0.599) ns

Level of significance: $^{*}p<0.050$, $^{**}p<0.01$, $^{***}p<0.001$, *ns*, non-significant

consumers' e-waste disposal behavior depends on (is moderated by) generational transformations in the perception of gender. The beta values for males and females regarding the moderating effect of identified motivation are significant ($\beta_m=0.44$** and $\beta_f=0.35$**) (see Figs. 2 and 3). The results for other motivations are as follows: intrinsic motivation is ($\beta_m=0.42$** and $\beta_f=-0.03$); external motivation ($\beta_m=-0.05$ and $\beta_f=0.34$*); habit ($\beta_m=0.15$ and $\beta_f=0.1$); and introjected motivation ($\beta_m=-0.09$ and $\beta_f=0.09$). The results regarding moderation show that identified motivation is more important for males than females in terms of consumers' e-waste disposal behavior. In contrast, the intrinsic motivation effect is less strong for women than for men, and external motivation is more important for females than for males. The moderating role of identified motivation is subsequently linked to sustainable e-waste disposal behavior. The results highlight that the relationship between identified motivation and e-waste behavior is significant. However, the effects of intrinsic and extrinsic motivations on sustainable e-waste disposal behavior depend on gender, so the moderating role of intrinsic motivation is stronger for males, and that of extrinsic motivation is stronger for females. The moderating role played by identified motivation is related to sustainable e-waste disposal behavior. Correspondingly, a bootstrap estimation approach with 200 samples was applied to ascertain the indirect effect; the indirect coefficient was significant.

Discussion

The main aim of the present study is to analyze the validity of self-determination theory as a concrete structure for sustainable e-waste disposal behavior. Self-determination motivations positively improve consumers' sustainable e-waste

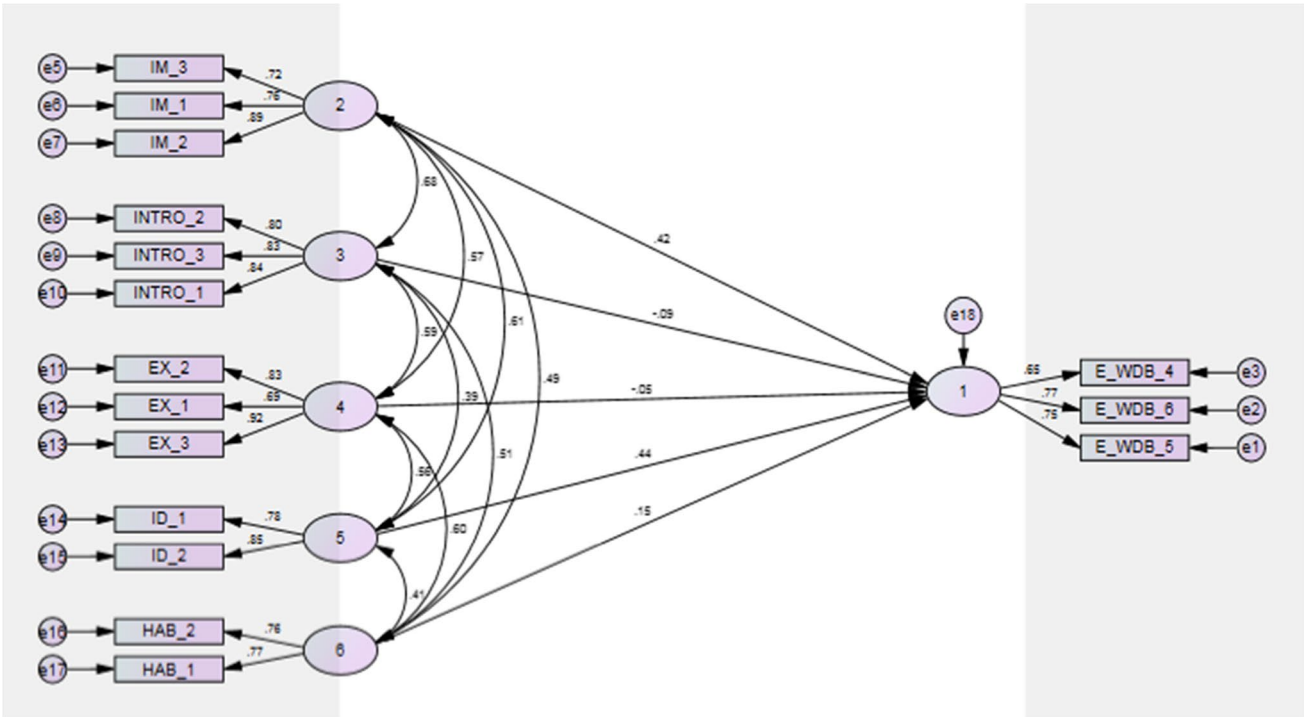

Fig. 2 Male moderation relationship

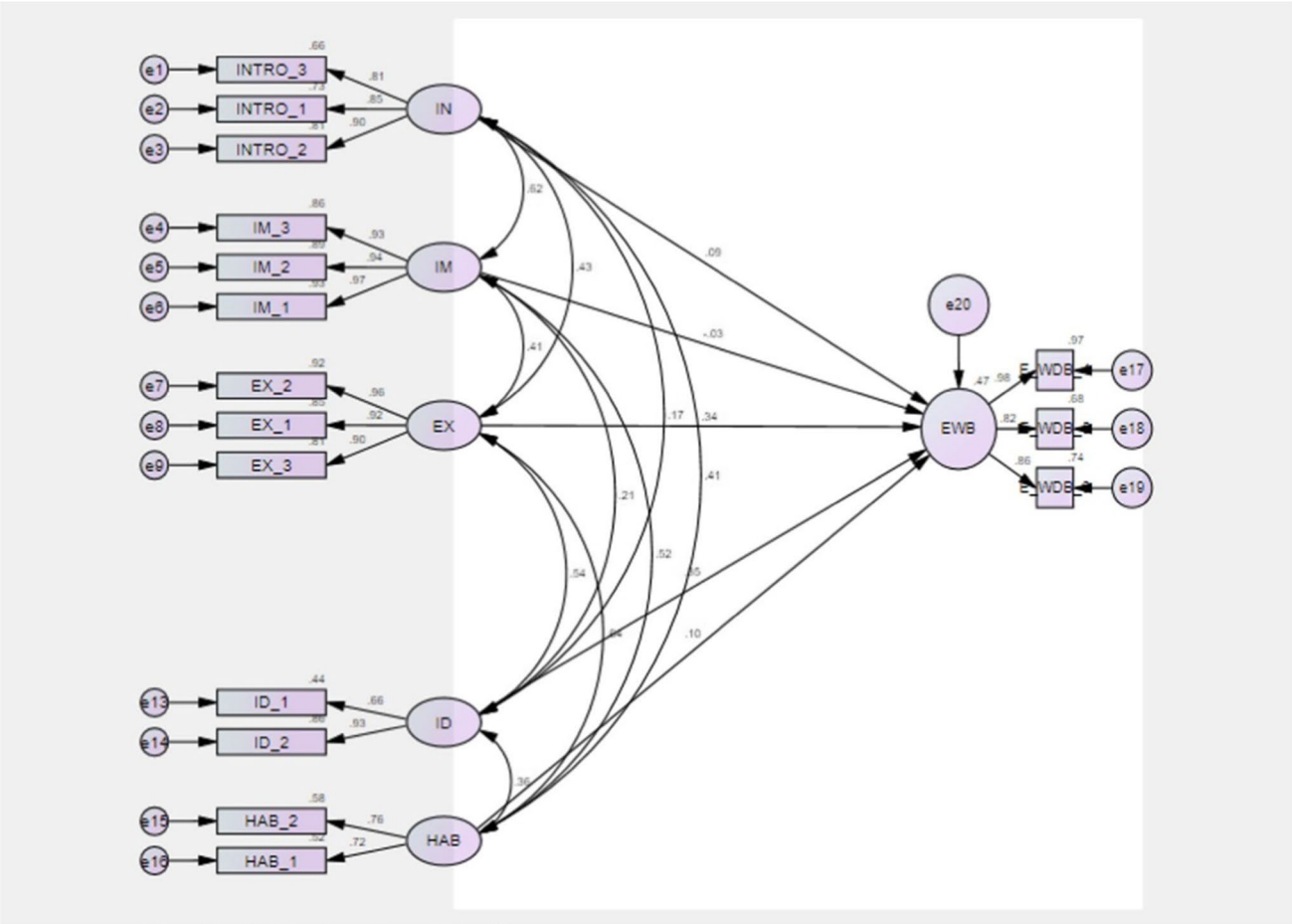

Fig. 3 Female moderation relationship

disposal behaviors through combined effects. While some results obtained coincide with previous research findings (Gilal et al. 2019), the results regarding intrinsic and identified motivations in relation to sustainable e-waste disposal behavior are new. This is the first time that an attempt has been made to connect self-determination theory to motivations in the context of sustainable e-waste disposal behavior.

Regarding *H1*, the present study evidenced the positive and insignificant effect of intrinsic motivation on sustainable e-waste disposal behavior ($\beta = 0.180$, t-value $= 1.730 < 1.96$); thus, *H1* was not supported. However, MGM revealed a significant influence on sustainable e-waste disposable behavior among males (see Table 4). This result is consistent with (Islam et al. 2021a, b), who also evidenced the significant role of intrinsic motivation.

Furthermore, this study also confirmed the positive and significant influence of identified motivation on sustainable e-waste disposal behavior ($\beta = 0.439$, t-value $= 4.548 > 1.96$); thus, *H2* was supported. This result suggests that, if identified motivation increases by 1 unit, it will lead to c. 44% changes in sustainable e-waste disposal behavior. This finding is in line with the recent study of Liu and Chiang (2019), who highlighted the importance of identified motivation in the context of e-waste.

Intrinsic and identified motivations have a greater impact on the disposal behavior of e-waste. These results are in line with those of Ryan and Deci (2020), who found a significantly positive effect of intrinsic and identified motivations. Therefore, the best way to encourage people regarding e-waste disposal behavior is via social media and community forums. The results also show the more positive reasons there are for an individual to implement sustainable e-waste disposal behavior, the greater the likelihood is that the person will focus on these reasons for sustainable e-waste disposal behavior. Our results also show that intrinsic motivation is strongly linked to identified motivation, which highlights the importance of integrated consumer motivations in relation to sustainable e-waste disposal behaviors.

In addition, concerning *H3*, this research witnessed the weakest and most insignificant effect of introjected motivation on sustainable e-waste disposal behavior ($\beta = 0.003$, t-value $= 0.029 < 1.96$); thus, *H3* is not supported. This

result implies that people are waiting or looking for others to perform certain actions. This result suggests that government and non-governmental organizations, educational institutions, and media channels can increase awareness and encourage people to adopt sustainable e-waste disposal behavior by increasing feelings of guilt and negative emotions in relation to the non-adoption of sustainable behavior. This outcome is consistent with the prior work of Stancu et al. (2020), who also evidenced the insignificant impact of introjected motivation regarding waste in the clothing industry.

Similarly, this study could not find support for the effect of external motivation and habit on sustainable e-waste behavior (t-value < 1.96, p-value > 0.05); thus, *H4* and *H5* were not supported. However, considering the gender perspective (especially among females), external motivation has a positive and significant influence on sustainable e-waste disposal behavior ($\beta = 0.339$, t-value = 2.228 > 1.96) (see Table 5). This research finding is consistent with the prior work of Thi Thu Nguyen et al. (2019), who also evidenced that females show a strong motivational effect in relation to recycling.

Results regarding extrinsic and introjected motivations were incompatible with our hypotheses, which postulated that the greater a person's motivation for sustainable e-waste disposal behavior, the less likely it is to have a significant impact. Extrinsic and introjected motivations related to sustainable e-waste disposal behavior are less likely to have an impact on sustainable e-waste disposal behavior among older people.

Our findings have significant implications for practice. For example, policymakers can encourage more, and a wider variety of, positive opinions regarding the importance of sustainable e-waste disposal behavior and reduce the occurrence of negative e-waste disposal behaviors. In addition, the moderation analysis showed that identified motivation partly explains why consumer behavior regarding sustainable e-waste disposal behavior generates subsequent motivations. Intrinsic and identified motivations regarding sustainable e-waste disposal behavior depend on gender, such that the moderating relationship is weaker for men than for women, and the impact of identified and external motivations on sustainable e-waste disposal behavior is weaker for women than for men. Finally, our results show that identified motivation and intrinsic motivation are significant, while extrinsic motivation and introjected motivation are insignificant, which merits further discussion. First, intrinsic and identified motivations are positively associated with sustainable e-waste disposal behavior ($p < 0.05$). These results suggest that, when an individual has high intrinsic and identified motivation, he/she is likely to experience low intrinsic and identified motivation. Second, our results reveal that the effect of identified and intrinsic motivations are significant. In this context, some cultures do not have a strong capacity for individuals sustaining a positive outlook of themselves (Horkheimer and Adorno 2020), supporting Jensen and Bro's (2017) arguments regarding the intrinsic need of people to possess, improve, and maintain a positive vision of themselves.

Table 5 Standardized regression weights (default model: female)

			Estimate
1	←	2	−0.03
1	←	3	0.09
1	←	4	0.34
1	←	5	0.35
1	←	6	0.1

Practical and theoretical implications

The results of this study have vital theoretical and practical implications for households and policymakers. First, self-determination theory postulates that consumers' intrinsic motivation is determined by self-sufficiency, competition, and relationship. Therefore, dozens of studies based on self-determination theory have been published showing that innate identified and intrinsic motivations are key, having a significant effect on individuals' behavior in various aspects of life, such as life satisfaction, well-being, weight control, innovation, and employee performance (Alkadash et al. 2020). Nevertheless, there is still a gap in studying the robustness of self-determination theory in the context of consumers' e-waste disposal behavior. Consequently, this study extends the prior literature, strengthening the use of self-determination theory in the fields of management, organizational behavior, health, and consumer behavior, by studying the effect of intrinsic and identified motivations on consumers' sustainable e-waste disposal behavior. Second, the link between technology e-waste disposal (TED) and intrinsic and identified motivations that influence consumers' sustainable e-waste disposal behaviors has important implications for policymakers. Our results show that intrinsic and identified motivations can encourage the development of sustainable e-waste disposal behavior. Governmental agencies and manufacturing companies can try to inform consumers of sustainable e-waste disposal behaviors and boost behavior through social media campaigns (rather than traditional media). People can also share their know-how on e-waste recycling. Third, as detailed in the Introduction, in the future, Pakistan will be generating even more e-waste by 2050, and this is already a major issue (Nigam et al. 2021). Given the forecasted increase in global e-waste production, our study helps solve this problem efficiently. It would be relatively inexpensive to motivate consumers to dispose of e-waste by returning products to companies for

recycling rather than spending billions of dollars on traditional marketing methods. Fourth, this study addresses the e-waste issue and opens new opportunities for campaigning in new ways. Therefore, marketers can extract leverage from the cost of e-waste and save up to 40% on material costs (Thi Thu Nguyen et al. 2019), simply by returning their products to scrap merchants for further processing. In particular, policymakers can establish delivery centers or enter into deals with local scrap dealers, who can attract consumers by paying reasonable prices for obtaining scrap products for recycling (Cao et al. 2020; Nigam et al. 2021). Finally, government authorities can use this study to develop laws relating to the disposal of e-waste. Leaders should create an eco-friendly environment by educating people via social media regarding sustainable e-waste disposal behavior, informing them about the significant harm of e-waste and the hazardous effects both for the environment and public health.

Future research and limitations

Despite the unique contribution of this study in consumer and self-determination theory, it has three limitations. First, the research is in the context of Pakistan. It has analyzed the effects of identified and intrinsic motivation, as well as introjected and extrinsic motivations and habit, thus assimilating or combining motivations for sustainable e-waste disposal behavior. Since this study is centered on consumer behavior regarding the disposal of e-waste, the results are un-generalizable in other contexts, such as energy conservation behavior or clothing disposal behavior (Sintov and Schuitema 2018). This study can be validated in the future in the context of energy conservation in Pakistan by improving citizens' behavior in a similar manner to sustainable e-waste disposal behavior by providing various stimuli, rewards, and punishments. Second, our study has reconciled how sustainable e-waste disposal behavior interacts with self-determination theory. This study's findings can be enhanced in future research by implementing self-determination theory's OIT to classify consumer motivations (e.g., intrinsic, identified, introjected, and external motivations) for sustainable e-waste disposal behaviors (Ryan and Deci 2020). In particular, this study can be used to explore the effects of consumers' identified, introjected, and external intrinsic motivations and subsequent sustainable e-waste disposal behaviors. Third, in Pakistan, traditional customs and practices lead to women's subordinate status, thereby denying girls equal access to education. Social and religious structures often quote religious teachings out of context, further undervaluing the need to educate girls. This is the major limitation in our study. In future, results may vary if there is an equal ratio of females and males.

As previously elaborated, e-waste is an evolving problem both in developed and developing countries, including India and China, which face an exponentially growing e-waste problem. Hence, although the approach adopted by this study may be generally applied beyond the geography of Pakistan, the generalizability of its findings must be treated with caution in the context of countries with different cultural values to those of Pakistan (e.g., Norway, Australia, Canada, New Zealand, the USA, Holland, Germany, and Switzerland). Thus, our hypotheses must be examined and tested in several developed nations. In conclusion, this study proposed six hypotheses, of which four were found to be insignificant. For instance, the impact of identified and extrinsic motivations was not significant, as was the case for habit. These insignificant results require further investigation.

Author contribution This research study was possible with the valuable contributions from the following: conceptualization, A.K.G. and S.A.Q.; methodology, A.K.G and M.F.; software, M.F., R.G.G. and F.G.G; validation, S.A.Q., F.G.G, and A.K.G.; formal analysis, M.F., A.K.G, and S.A.Q.; investigation, A.K.G. and R.G.G.; resources, F.G.G.; data curation, A.K.; writing (original draft preparation), M.F.; writing (review and editing), S.A.Q.; visualization, R.G.G. and A.K.G.; supervision, M.F.; project administration, F.G.G.; funding acquisition, M.F. All authors have read and agreed to the published version of the manuscript.

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Data availability Data available on request from the authors.

Declarations

Ethics statement The studies involving human participants were reviewed and approved by Sukkur IBA University.

Consent to participate The participants provided their written informed consent to participate in this study.

Consent to publish The authors affirm that human participants provided informed consent for the publication of material.

Competing interests The authors declare no competing interests.

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