
7. Understanding recycling behavior in the university: a case study from Southern Chile

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1. INTRODUCTION

Solid waste generation by the modern consumer society has grown steadily in line with world population growth, as well as with the economic development of countries (Hernández-Berriel et al., 2016; Universidad de Chile, 2016). The generation of municipal solid waste (MSW) in Latin America increases at an estimated rate of ~5 percent per year, moving from 130 million tons produced in 2012, to 220 million tons projected by 2025 (Hoorweg and Bhada-Tata, 2012). The previous projection, which is based on empirical data, makes waste management crucial, considering the threat that such a volume of solid waste may represent for public health and thus for local and national governments.

On average, the most developed countries of the world, members of the Organisation for Economic Co-operation and Development (OECD), generate around 2.2 kg/capita/day (Universidad de Chile, 2016). In Chile (18 million population), solid waste generation is estimated at 1.2 kg/capita/day, totaling about 7.5–7.8 million tons of MSW waste per year (ibid.).

Recycling is one of the most powerful alternatives to regular unmanaged waste disposal; it promotes material savings by converting waste into new materials and objects, and moreover, it also helps in the reduction of greenhouse gas emissions by limiting the consumption of fresh raw materials (Geissdoerfer et al., 2017). Recycling is the third component of the ‘Reduce, Reuse, and Recycle’ waste management strategy. It can be oriented into a circular economy approach, in which resource use, waste production emissions and energy are minimized to create a closed system of positive interactions between the economy and the environment (Geissdoerfer et al., 2017; González et al., 2018). In Chile, it is estimated that ~85–95 percent of the total MSW ends up in landfills, and only 5–15 percent is destined for recycling, including organic waste composting (Comisión Nacional del Medioambiente [CONAMA], 2009; Vásquez, 2011). This contrasts with what happens, for example, in Germany, where about 62 percent of the total MSW is recycled, surpassing the European Union’s target goal of recycling over 50 percent of MSW by 2020 (Fischer, 2013).

Since the 1970s, universities from around the globe have encouraged sustainability practices (Wright, 2002). This was first declared in 1972, at the United Nations Conference on the Human Environment held in Stockholm (United Nations, 1973). Here, special importance was given to higher education entities to act as spearheads on environmental practices, including efforts to improve waste management models, energy reduction and greener buildings (ibid.). In this scenario, the idea of promoting sustainability on university campuses emerged. Thus, each educational entity should promote, according

to its capacity, a sustainable environment and/or the implementation of flexible models and policies to be used by the academic community (Velazquez et al., 2006). Currently, there is an international network representing over 80 universities from 30 countries that promotes commitment to sustainability and leadership in research that encourages best practices by universities and knowledge mobilization (i.e., the International Sustainable Campus Network [ISCN], 2018). In Chile there are 14 universities that currently participate in a national network of sustainability campuses called Red Campus Sustentable (RCS), which has similar objectives to the ISCN (Eskuche, 2019; RCS, 2019). Their concrete actions support four of the 17 Sustainable Development Goals: health and wellness, quality education, climate action and partnerships to achieve the goals (RCS, 2019).

The Universidad de La Frontera (UFRO) has been part of the national network of sustainability campuses since 2019 (Eskuche, 2019). Located in Temuco (~300 000 inhabitants), the main city of the Araucanía region located ~650 km south of Santiago de Chile, UFRO is the largest university in the Araucanía region, with six faculties and around 9000 students. Around 340 000 tons/year of MSW are generated in the Araucanía region, representing ~4.5 percent of the total national MSW of Chile. About 57 percent of the people of the Araucanía region declare that they separate waste for recycling, which is above the Chilean average (~50 percent; Browne et al., 2016). It is important to clarify that this does not mean that >50 percent of the waste is recycled, but how many people state that they separate at least some materials for recycling (Browne et al., 2016; CONAMA, 2009). At UFRO, there is an estimated total daily production of MSW that varies between 668 and 1065 kg, from which ~45 percent is classified as non-recyclable, ~42 percent corresponds to compostable organic waste, and about 13 percent to recyclable waste, like paper (~10 percent), plastics, glass and metal (~3 percent) (Sepulveda, 2019). Waste management on campus is the main concern of students, academics and workers of the university, followed by paper misuse (Riveros, 2019). Moreover, 636 out of 909 surveyed people from the university declared that they separate waste for recycling on a regular basis at home (i.e., 70 percent), and about 50 percent mention the use of recycling containers on campus (ibid.). Nevertheless, there is no official data quantifying current amounts of waste disposed for recycling at UFRO. Although several recycling campaigns have been implemented since the mid-1990s, most of them have not continued long term, given the lack of a coordinated support from the university, lack of funding and/or motivation of the people involved (Barra et al., 2017). What determines the motivation of someone to recycle in this scenario?

Individual behaviors dealing with waste separation can be of diverse origins, from aesthetic to economic motivations, associated with more personal altruistic beliefs, or external normative regulations (Moreno-Ávila and Rincón-Salazar, 2009). Individual beliefs on this matter can be influenced by the perception that each person has of the natural environment (Palavecinos et al., 2016). For instance, several works have identified that women usually show greater concern for the environment and more pro-environmental and ecological behaviors than men (Browne et al., 2016; Palavecinos et al., 2016). Understanding factors that influence people's ecological behavior, such as waste separation, is relevant information that can successfully orientate initiatives, campaigns and policies to foster recycling. Previous studies in the United States have identified recyclers as older and wealthier, living in households with fewer members, and more liberal in political orientation (Morgan and Hughes, 2006). In Europe, it has

been identified that behavior patterns that lead to waste reduction are seldom socially oriented, and are very reliant on purely personal ‘altruistic’ attitudes (Cecere et al., 2014). In Chile, no study has focused on understanding which variables are common to people who recycle.

In this work, through a survey analysis, the main attributes of students who declared they separated solid waste for recycling on a regular basis were investigated. We sought to learn about ecological behaviors of students at UFRO. For this, two guiding questions were used: (1) Which variables are associated with waste separation for recycling by students at UFRO? (2) What are the main motivations for the practice of waste separation for recycling by students at UFRO? Based on these, the objective of this work was to characterize the main attributes of students who recycle solid waste in the university, unveiling variables that can favorably predict this behavior within the studied population. Thus, variables favorably associated with the separation of solid waste in UFRO students were considered, analyzing which motivations are identified for waste separation by students who declare they recycle. Finally, information and ideas to encourage solid waste separation in university students were considered, presenting this case study based on local empirical evidence, as an example to support recycling plans at a broader level.

2. METHODS

2.1 The Survey Instrument

An online survey was designed and distributed to ascertain basic behavioral information on waste separation from students, using the mailing lists provided by UFRO. All participants agreed to participate in the investigation voluntarily, and each participant was assigned an ID to ensure protection of confidentiality and the anonymity of their data subject to the Declaration of Helsinki (World Medical Association [WMA], 2014). A total of 262 surveys were answered from which 261 were completed and processed through the QuestionPro platform, which was available for online responses for about one month (99.6 percent valid answers, December 2018; QuestionPro, 2018). The questionnaire was designed to create a correlational model investigation (*sensu* Palavecinos et al., 2016). Three sections were included: (a) sociodemographic data; (b) behavioral information; and (c) motivation/values related with waste separation (Table 7.1).

First, (a) sociodemographic data were considered: gender, age, ethnicity (i.e., belonging to an indigenous community or not), faculty (i.e., categorical data identifying one of the six faculties of the university), and student status (undergraduate/graduate student). Second, (b) behavioral information included questions dealing with: spiritual beliefs of the participants, the importance of being involved in social associations, regularly practicing physical activity (World Health Organization [WHO], 2010), and how closely connected they felt to rural/natural environments. Finally, each participant was asked if he or she separated waste for recycling on a regular basis (Table 7.1) – regular basis, is understood to mean that each person separates waste at least on a weekly basis (Browne et al., 2016). The survey we used to collect our data was peer reviewed by two professionals with experience in sustainability and sociological surveys, respectively. Moreover, a short validation process was performed with ten students.

Table 7.1 *Description of the data obtained by the applied instrument*

| Data | Description (Alternatives) |
|---|--|
| (a) Sociodemographic data | |
| Gender | Female/Male/Other |
| Age | Years |
| Ethnic origin* | Indigenous origin/No indigenous origin |
| Student status | Undergraduate/Graduate |
| Faculty | Faculty of Agricultural and Forestry Sciences/ Faculty of Education, Social Sciences and Humanities/Faculty of Engineering and Sciences/Faculty of Legal and Business Sciences/ Faculty of Medicine/Faculty of Dentistry |
| (b) Behavioral information | |
| Select if you actively participate in any spiritual group* | Catholic/Protestant/Ethnic, Indigenous/Oriental/ Other/None |
| Select if you belong to some community participation organization* | None/Student organization/Neighborhood/ Sports/Ecological/Pastoral/Social/Other |
| Do you practice regular physical activity, (i.e., at least three times a week > 40 minutes each time)? (Adapted from WHO, 2010) | Yes/No |
| Select whether you have lived or resided temporarily (> three weeks) in a rural/natural environment* | Yes/No |
| Do you separate waste for recycling at home on a regular basis? (Browne et al., 2016) | Yes/No |

Note: Variables marked with an (*) were combined from several categories into a binary format to facilitate analysis (e.g., ethnic origin options included: Mapuche/Huilliche/Pehuenche and others, which were recategorized into: indigenous origin/no indigenous origin).

Moreover, to understand which motivations were related with waste separation, for the subset of students who declared they recycled ($n = 149$), a set of statements and questions dealing with (c) motivation/values related to waste separation were included. This was aimed at identifying pro-environmental conducts, understood as conscious human behaviors to protect, preserve and/or minimize the negative impact on the environment (Ones et al., 2015; Palavecinos et al., 2016; Table 7.2).

2.2 Data Analyses

The QuestionPro web-based software was used to explore and download the raw databases (QuestionPro, 2018). Sociodemographic and behavioral information of the participants was synthesized using percentages, and to create tables contrasting the information of students that either separate waste for recycling, or not. The information related to motivations/values of students who declared they practiced waste separation was conducted in a similar way. All statistical analyses were performed using R (R Development Core, 2018).

Table 7.2 Instrument to characterize motivations/values related to students that declared they practice waste separation (n = 149)

| | Motivation/Value |
|--|--|
| I recycle because . . . | <ol style="list-style-type: none"> 1. It is a habit, I learned it in my family and we all do it/We all do it in my group of friends 2. I am interested in human sustainability and doing my bit 3. I am concerned about the problem of waste and the future of the planet 4. It is a way to activate the local economy |
| What motivates me to continue recycling is . . . | <ol style="list-style-type: none"> 1. I like to contribute to the local economy 2. I like to motivate more people to recycle 3. Media campaigns 4. I feel good about myself and that's enough for me |
| How can recycling be encouraged in the city (Temuco)?* | <ol style="list-style-type: none"> 1. Incentives and outreach 2. Penalties, fines to people that do not separate waste 3. To implement a differentiated waste collection/More recycling points in the city 4. To encourage recycled materials economy |

Note: For the last question of this section (*), respondents could mark several answers.

To identify variables that were significantly related to the separation of waste for recycling, classification tree analyses were used (library ‘party’; Hothorn, Hornik and Zeileis, 2012; R Development Core, 2018). This was possible because in the database waste separation was treated as a dichotomous (i.e., logistic) variable; either you separated (i.e., presence: 1) or not (i.e., absence: 0). Thus, it was possible to predict waste separation as a function of sociodemographic and/or behavioral variables (Table 7.1). At each step of the analysis, one explanatory variable was selected from all available variables based on the best separation of two homogeneous groups using a permutation test; this point was determined by a numerical value (threshold) of the explanatory variable (Hothorn et al., 2012). The minimum sum of weights considered in the analyses were ten participants for splitting, and seven participants for terminal nodes (ibid.).

3. RESULTS

From the 261 students that participated in the survey, 149 (57 percent) declared they separated waste for recycling, while 112 (43 percent) stated that they did not perform any waste separation (Table 7.3). Considering the sociodemographic data, women separated more than men and three-quarters of graduate students declared they recycled, compared with only about half of undergraduates (Table 7.3). When looking at the behavioral information, people who mentioned that they have some rural/natural environment experience, as well as people that participated in associations/organizations and performed regular physical activity seemed to recycle more than those that did not have a relationship with rural places, nor participated in associations and/or doing exercise regularly (Table 7.3).

Table 7.3 *Description of the participants of the survey (n = 261)*

| Variable | Separate Waste (%) (n = 149) | Not Separate Waste (%) (n = 112) | Total (%) (n = 261) |
|--|---------------------------------|-------------------------------------|------------------------|
| <i>(a) Sociodemographic data</i> | | | |
| <i>Gender</i> | | | |
| Female | 109 (61%) | 72 (39%) | 181 (69%) |
| Male | 39 (50%) | 39 (50%) | 78 (30%) |
| Other* | 1 (50%) | 1 (50%) | 2 (1%) |
| Total | 149 (57%) | 112 (43%) | 261 (100%) |
| Average age (\pm standard deviation) | 22.3 \pm 4.7 | 24.9 \pm 6.3 | 23.7 \pm 5.8 |
| <i>Ethnic origin</i> | | | |
| Indigenous origin | 28 (57%) | 21 (43%) | 49 (19%) |
| No indigenous origin | 121 (57%) | 91 (43%) | 212 (81%) |
| <i>Student status</i> | | | |
| Undergraduate | 116 (53%) | 101 (47%) | 217 (83%) |
| Graduate | 33 (75%) | 11 (25%) | 44 (17%) |
| <i>(b) Behavioral information</i> | | | |
| <i>Religion/Spirituality</i> | | | |
| No | 102 (56%) | 81 (44%) | 183 (70%) |
| Yes | 47 (60%) | 31 (40%) | 78 (30%) |
| <i>Participation in associations/organizations</i> | | | |
| No | 92 (54%) | 77 (46%) | 169 (65%) |
| Yes | 57 (62%) | 35 (38%) | 92 (35%) |
| <i>Rural/Natural environment experience</i> | | | |
| No | 36 (42%) | 49 (58%) | 85 (33%) |
| Yes | 113 (64%) | 63 (36%) | 176 (77%) |
| <i>Practice regular physical activity (exercise)</i> | | | |
| No | 51 (50%) | 52 (50%) | 103 (39%) |
| Yes | 98 (62%) | 60 (38%) | 158 (61%) |

Note: Information is presented from students who declared they did or did not separate waste for recycling.

The age of the participants was the most important predictor of waste separation, followed by rural/natural environment experience and exercise (Figure 7.1a). The highest probability (about 75 percent) for waste separation for recycling was for students older than 21 years old, who practice physical activity on a regular basis. When removing the age variable from the analyses, natural environment experience was significantly related with a higher probability for waste separation (~65 percent; Figure 7.1b).

Considering the motivations for recycling, most students that declared to separate waste for recycling ($n = 149$) mentioned that they did it because they felt good personally, or because they wanted to encourage more people to recycle (Figure 7.2a). Almost three-quarters of the people that separated waste identified their main motivation for recycling as their concern about the 'waste problem' and the 'future of the planet' (Figure 7.2b). To encourage recycling in the city, most people mentioned that the solution is to implement a differentiated waste collection and more recycling points (Figure 7.2c).

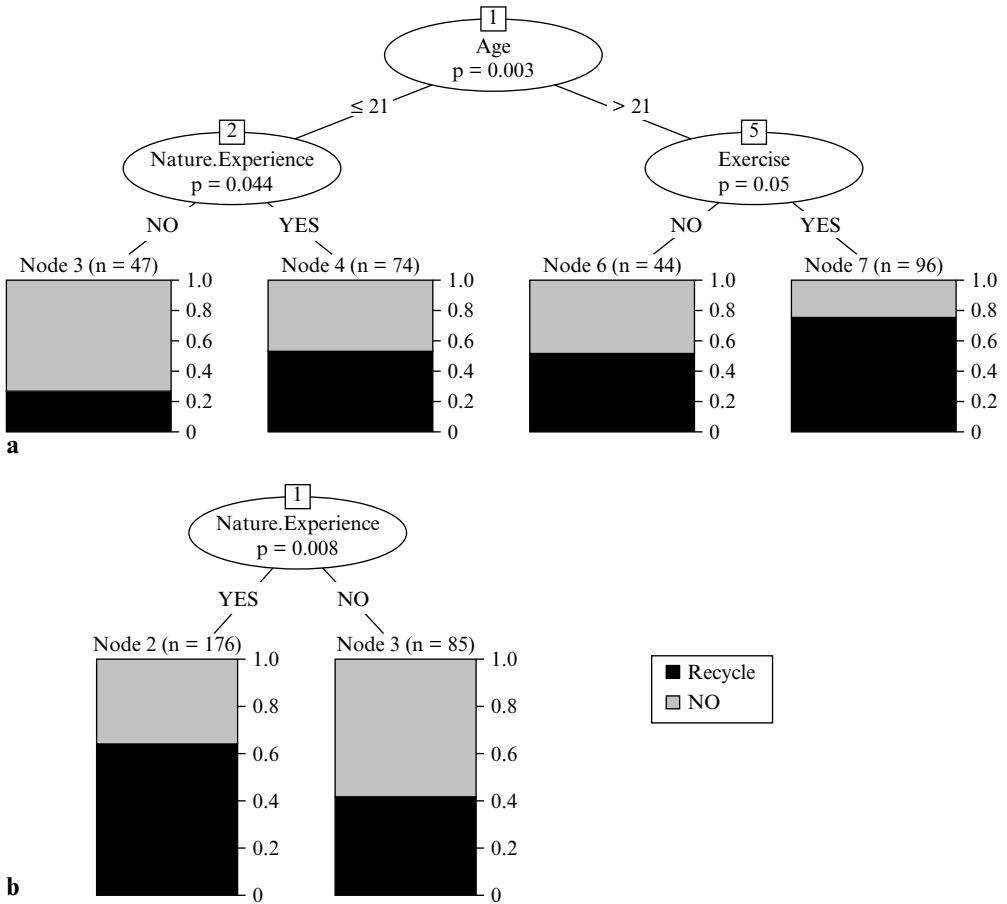


Figure 7.1 Classification tree analyses to predict the separation/no separation of waste by students of UFRO ($n = 261$), based on a conditional inference tree model. The encircled explanatory variables are those showing the strongest association with the response variable (i.e., separation of waste = Recycle; no separation of waste = NO). Values on lines connecting explanatory variables indicate splitting criteria; for example, the first split of Figure 7.1a separates students ≤ 21 years old (left side of the split) from those > 21 years old (right side of the split). Numbers in boxes above the explanatory variable indicate the node hierarchical number. P-values at each node represent the test of independence between the listed independent variable and the response variable. ‘ $n = x$ ’ over terminal nodes indicates the number of persons classified in that node. The predicted waste separation is given by the terminal block representing the probability of waste separation (Recycle, dark part of the block) or no waste separation (NO, gray part of the block). Explanatory variables included were all sociodemographic and behavioral information from Table 7.1 (Figure 7.1a). For Figure 7.1b, the sociodemographic variable ‘age’ was not included

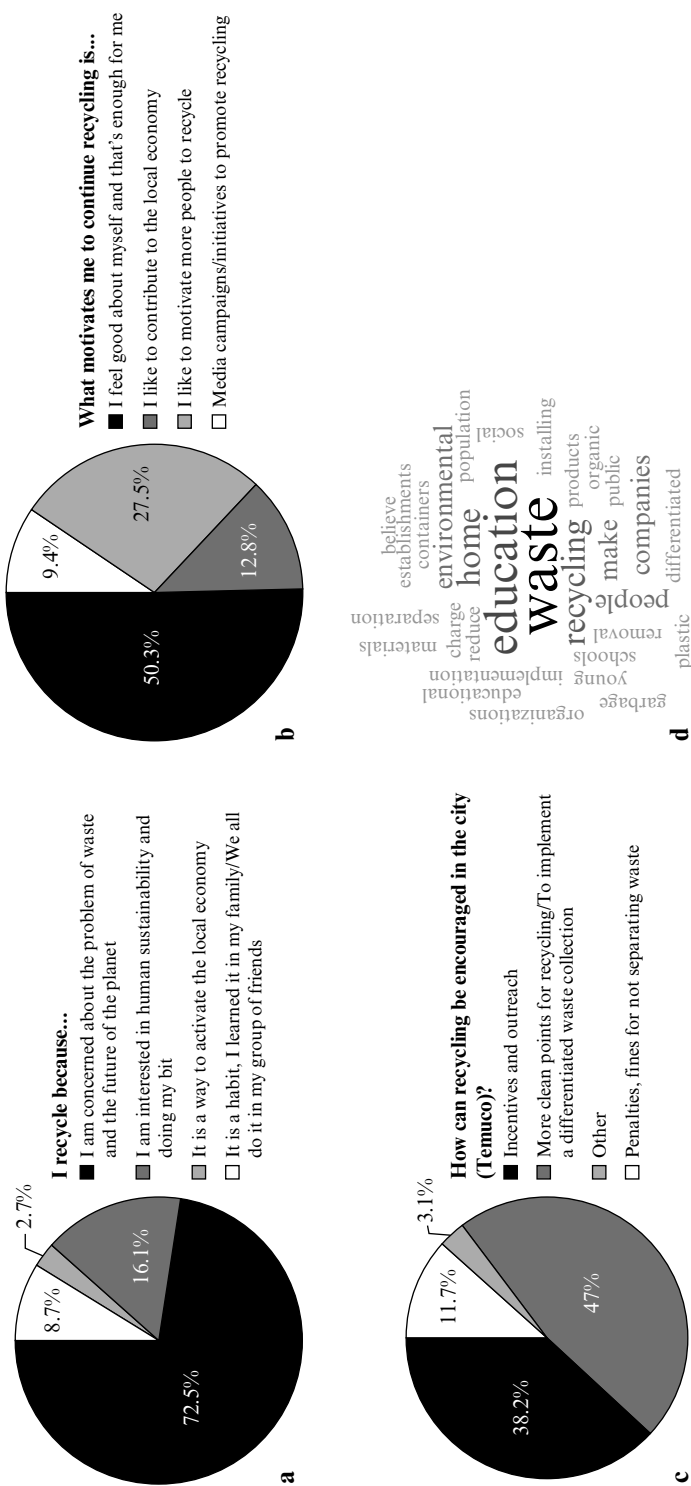


Figure 7.2 Main motivations identified by students who declared they separated waste for recycling at UFRO (n = 149; see Table 7.2). The word cloud (Figure 7.2d) identifies the most repeated words when replying to 'How can recycling be encouraged in the city?' Those who answered 'Other' were able to write down their ideas. The larger the type size of the word, the most repeated among the received answers

4. DISCUSSION

4.1 Attributes of Students Who Separate Waste for Recycling at the University

Based on our survey, about 57 percent of the students at UFRO declared that they separate waste for recycling, which is quite concordant with the official data of Chile for the Araucanía region (Browne et al., 2016). This percentage is a little more conservative than what has been reported previously at UFRO, when including academics and administrative staff (~72 percent; Riveros, 2019). This makes sense considering that the age of the participants was the most important variable in predicting recycling, and most academics and workers of the university are older than 21 years (the significant threshold given by the analysis) (Figure 7.1a). Similarly, other studies in Chile have also reported that older people present more ecological behaviors than younger ones, independent of whether people live in rural or urban environments (Moyano-Díaz et al., 2017).

The rural/natural environment experience was also identified as one of the variables that increases the chances of recycling by students. This means that someone who has had a more direct connection with rural or natural environments is more likely to separate waste than someone associated with urban environments. This could be understood when considering that separating organic waste is traditionally done in rural places in Chile, for feeding the animals and/or composting for the orchard (Browne et al., 2016). In addition, other studies have identified that rural places manifest a higher connection with nature, associated with higher pro-environmental behaviors, positive emotions towards nature, and even happiness (Cuervo-Arango et al., 2013; Moyano-Díaz et al., 2017).

The third most important variable in predicting waste separation probability by students at the university was the regular practice of physical activity, which could be related with the more proactive behavior of those who recycle (WHO, 2010). Considering that many sports/exercises are performed in the outdoors, a higher pro-environmental behavior and positive emotions towards nature could also be expected for this group of people (Figure 7.2a; Cuervo-Arango et al., 2013).

Considering the motivations of people to recycle, almost three-quarters of the students that separate waste on a regular basis declared that they did it because they were concerned about waste as a problem (Figure 7.2a). This can be considered as altruistic behavior of the students, who assume responsibility for taking care of their environment, as they acknowledge there is a problem. Similarly, when studying reasons for waste separation in the United States, altruistic behaviors and recycling have been identified as associated with more educated people and of liberal political orientation (Morgan and Hughes, 2006). Nevertheless, personal satisfaction was identified as an important motivation for students to recycle (Figure 7.2b), which could be further analyzed by considering the motivational relationship that could be established among recycling and happiness (Cuervo-Arango et al., 2013).

The implementation of more recycling points and the development of a differentiated waste collection campaign in the city was identified as the most important idea to promote recycling (Figure 7.2c). This has been the trend in many European countries like Germany, which has implemented an effective recycling system since the 1990s (Fischer, 2013). Education seems to be the way to go to encourage waste separation for recycling.

This was one of the most repeated word on the answers students gave when asked about personal ideas to promote recycling in the city (Figure 7.2d).

5. CONCLUSIONS

Waste separation for recycling in university students at UFRO (South Chile) was primarily influenced by the age of the students, their rural/natural environment experience, and the regular practice of physical activity. Further research could focus on differentiating whether age tends to influence students due an increased social awareness given the greater access to information/education, or the fact that the older the student, the more likely they are to live alone (i.e., away from their parents' house) and to implement recycling systems in their own homes. Considering rural/natural environmental experience influence over waste separation, it would be valuable to differentiate types of rural/natural environment experiences, rural areas, natural or green spaces, forests, and so on. Similarly, to examine the positive relationship found between waste separation and regular practice of physical activity would be important in understanding the possible interaction among exercise and natural environment experience, considering that several sports are practiced outdoors (i.e., rural/natural environments).

Considering the results of this study, the university should support environmental education in their curriculum, and the promotion of outdoor activities and support for regular physical activity (and/or exercise) that fosters contact with nature would be a good strategy to increase recycling.

This research provided us with empirical data at a local level that can contribute as guidance to promote environmental behaviors on a broader level. Similar approaches could be developed in a neighborhood or even a city with larger data analyses.

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