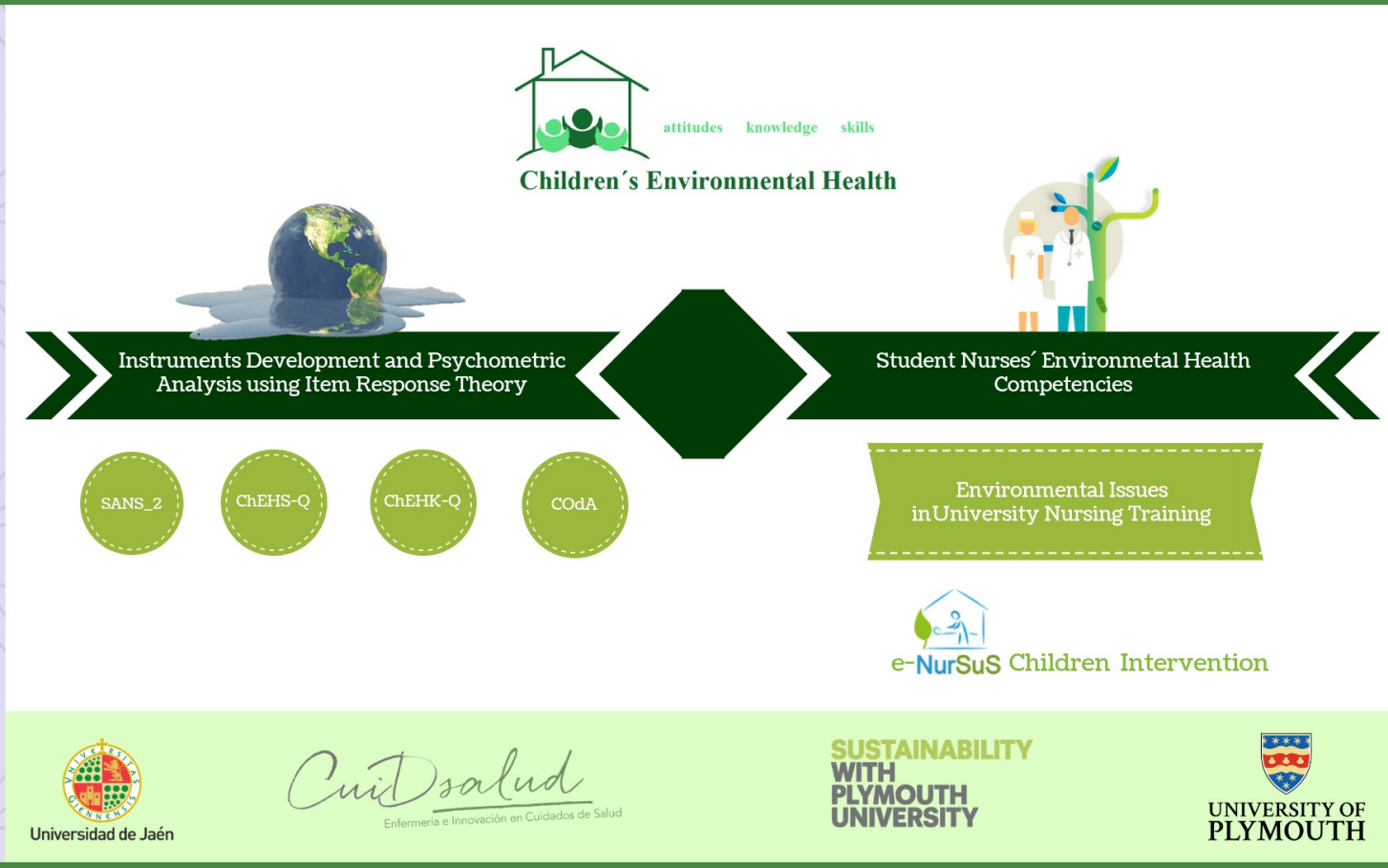
DOCTORAL THESIS

Development and Psychometric Analysis of Children's Environmental Health Knowledge (ChEHK-Q) and Children's Environmental Health Skills (ChEHS-Q) Questionnaires. The e-NurSus Children Intervention and Student Nurses' Environmental Health Competencies



Cristina Álvarez García

Directed by: Isabel M. López Medina and Carmen Álvarez Nieto

Universidad de Jaén

Escuela de Doctorado

DOCTORAL THESIS

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DEVELOPMENT AND PSYCHOMETRIC ANALYSIS OF CHILDREN'S ENVIRONMENTAL HEALTH KNOWLEDGE (ChEHK-Q) AND CHILDREN'S ENVIRONMENTAL HEALTH SKILLS (ChEHS-Q) QUESTIONNAIRES. THE E-NURSUS CHILDREN INTERVENTION AND STUDENT NURSES´ ENVIRONMENTAL HEALTH COMPETENCIES

PRESENTED BY:

CRISTINA ÁLVAREZ GARCÍA

DIRECTED BY:

ISABEL M. LÓPEZ MEDINA AND CARMEN ÁLVAREZ NIETO

JAÉN, MAY 2019

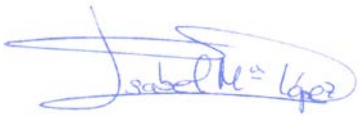
Universidad de Jaén
Departamento de Enfermería

ISABEL MARÍA LÓPEZ MEDINA, Lecturer in the Department of Nursing at the Universidad de Jaén

CERTIFY:

That the PhD student Cristina Álvarez García has carried out the work and research that has resulted in the Doctoral Thesis "Development and Psychometric Analysis of Children's Environmental Health Knowledge (ChEHK-Q) and Children's Environmental Health Skills (ChEHS-Q) Questionnaires. The e-NurSus Children Intervention and Student Nurses´ Environmental Health Competencies" under my direction and which has been approved for presentation and public defence before the corresponding commission to obtain a Doctorate Degree at Universidad de Jaén.

In Jaén, 25 March 2019



Sgd. Isabel María López Medina

Universidad de Jaén
Departamento de Enfermería

CARMEN ÁLVAREZ NIETO, Senior Lecturer in the Department of Nursing at the Universidad de Jaén

CERTIFY:

That the PhD student Cristina Álvarez García has carried out the work and research that has resulted in the Doctoral Thesis "Development and Psychometric Analysis of Children's Environmental Health Knowledge (ChEHK-Q) and Children's Environmental Health Skills (ChEHS-Q) Questionnaires. The e-NurSus Children Intervention and Student Nurses´ Environmental Health Competencies" under my direction and which has been approved for presentation and public defence before the corresponding commission to obtain a Doctorate Degree at Universidad de Jaén.

In Jaén, 25 March 2019

Sgd. Carmen Álvarez Nieto

For all nurses who struggle every day against climate change while working. Because “it´s not just a bits of paper and light bulbs”

Jones, Selby and Sterling (2010)

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Attention Deficit/Hyperactivity Disorder 27, 42, 43, 44
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ABSTRACT

Climate change has an important impact on health. The children are one of the most vulnerable population to environmental risks, especially under 5 years old. Nurses with adequate children´s environmental health competencies, defined as a set of related attitudes, knowledge and skills, can prevent or take care of different environmental problems. Therefore, the inclusion of environmental issues in the undergraduate nursing curriculum is essential. Nowadays, it is advantageous to take advantage of the use of new technologies, like blended-learning, to do so.

The general objectives of this research were four: (a) Build and validate a knowledge questionnaire and a skills questionnaire on children's environmental health for Spanish and English nursing students, (b) determine the attitudes, knowledge and skills related to children´s environmental health of students from different Spanish and United Kingdom universities, (c) evaluate the effectiveness of digital educational materials in training nursing students on children´s environmental health, and (d) assess the quality of the digital educational materials on children´s health and environment perceived by nursing students.

To fulfil the objectives, the research was developed in four main stages: (a) An observational cross-sectional study to validate the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q) in the Spanish context, (b) an observational, cross-sectional study to translate, adapt and validate the ChEHK-Q and the ChEHS-Q in the British context, (c) a multi-centre cross-sectional study to evaluate the attitudes, knowledge and skills of Spanish undergraduate nursing students, and (d) a quasi-experimental study of time series using pre-post educational intervention evaluation.

The ChEHK-Q and the ChEHS-Q were valid and reliable tools for measuring knowledge of and skills in children´s environmental health, respectively, among Spanish and British nursing students; the reliability values for the items and people were, .98, .70, .87 and .76, respectively, for ChEHK-Q and ChEHS-Q in the Spanish context; and .96, .79, .98 and .89, respectively, for ChEHK-Q and ChEHS-Q in the British context. Spanish student nurses had positive attitudes toward dealing with environmental problems (87.53% had at least good attitudes), but they lacked knowledge (only 20.35% had at least good knowledge) and skills (only 47.20% students

had at least good skills) to deal environmental problems. Child health nursing students from University of Plymouth also need more training to manage environmental problems or illness in children (22.41% of the Plymouth nursing students had good children's environmental health knowledge and 33.62% of them had good children's environmental health skills); in contrast, the 97.45% of them had good attitudes.

The level of attitudes, knowledge and skills of nursing students improved after the e-NurSus Children intervention ($p < .001$); it improved environmental health knowledge the most (39.02%), followed by skills (29.98%) and finally attitudes (15.81 %). In University of Jaén, skills improved the most (42.33%), followed by knowledge (37.61%) and attitudes (22.96%); and in University of Plymouth, knowledge (40.38%) improved the most, followed by skills (21.70%) and attitudes (11.06%). The quality of the educational materials was above average in all cases (in a scale 1 to 10). *Accessibility of textual content* was the best scored dimension, 7.94, and *Portability* the lowest, 7.05.

These findings clearly show the necessity to change the nursing curricula and include topics on children's environmental health, because nursing students have positive attitudes towards change but do not have the knowledge and skills needed to manage problems or illness caused by the environment. The e-NurSus Children intervention is useful to increase the attitudes, knowledge and skills related to children's environmental health among nursing students.

CHAPTER 1 INTRODUCTION

In recent years, scientific evidence has shown that climate change is potentially great risk to health. The climate is changing, including the intensity and frequency of extreme weather events, such as floods, heat or cold, changes in rainfall causing either drought or torrential rain, rising sea levels, ocean acidification, worsening air quality, and longer pollen seasons. Diseases caused by traditional forms of environmental pollution, such as coliforms in water or air pollution from solid fuels, are predominantly diarrhea, pneumonia and other infectious diseases. Modern environmental threats, by contrast, are linked mainly to non-communicable diseases, such as asthma, neurodevelopmental disorders, birth defects, obesity, diabetes, cardiovascular disease, mental health problems, and pediatric cancer (Anderko, Schenk, Huffling & Chalupka, 2016; Koppe, Kovalts, Jendritzky & Menne, 2004; Landrigan, Fuller, Fisher, Suk, Sly, Chiles & Bose-O´Reilly, 2019; McBridge, 2016; McDermott-Levy, Jackman-Murphy, Leffers & Jordan, 2019; Menne & Matthies, 2009; Nicholas & Breakey, 2017; Patz, Frumkin, Holloway, Vimont & Haines, 2014; Rice, Thurston, Balmes & Pinkerton, 2014; Sullivan-Marx & McCauley, 2017; Veenema, Thornton, Lavin, Bender, Seal & Corley, 2017). Children in rapidly industrializing countries are simultaneously confronted by both ancient and modern environmental threats to health (Figure 1.1) (Landrigan et al., 2019).

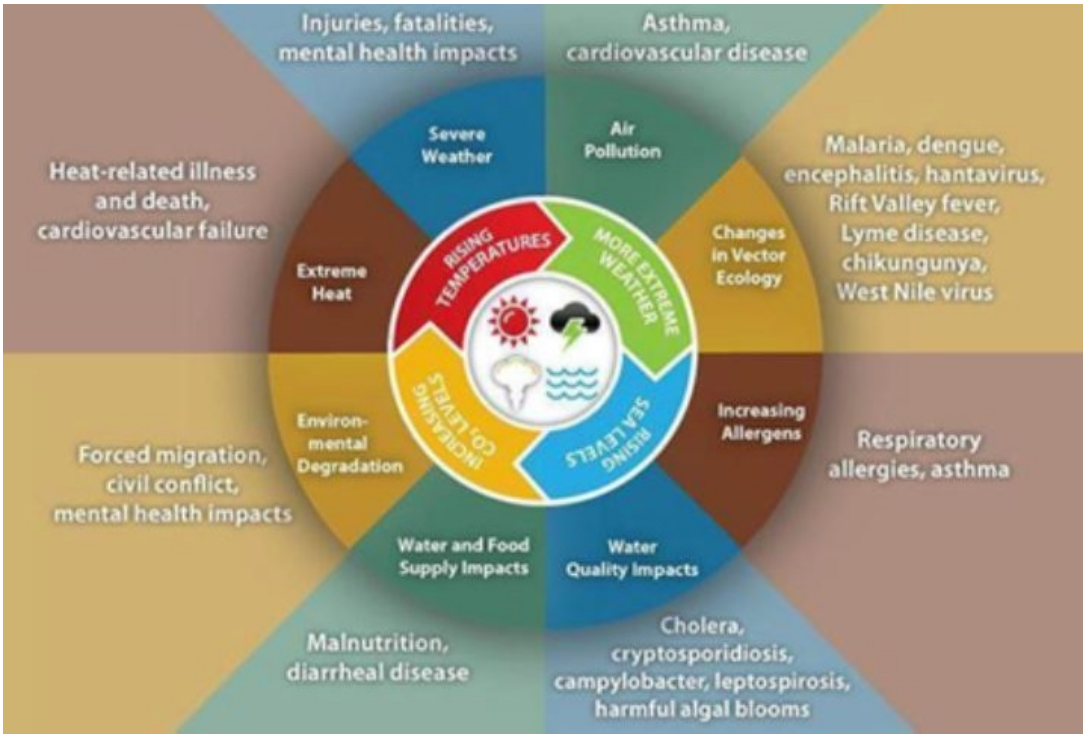

Figure 1.1. Impact of climate change on human health. Adapted from Anderko et al. (2016: 5).

Population health requires continuous protection to ensure, unpolluted internal and external ambient air, drinking water, adequate food, tolerable temperatures, stable climate, protection from ionizing and ultraviolet radiation, and high levels of environmental biodiversity. Excessive economic development presents secondary effects to the massive industrialization that generates a global deterioration of environmental conditions, with negative repercussions on human health (Ortega-García et al., 2001). Table 1.1 presents an overview of how climate change affects health.

Table 1.1. *Health Concerns Related to Climate Change*

Health concern	Examples of health vulnerabilities
Temperature-related morbidity	Cold and heat-related illness Respiratory and cardiovascular illness Increased occupational health risks
Effects of extreme weather events	Damage to public health infrastructure Injuries and illnesses Social and mental health stress due to disasters Occupational health hazards Population displacement
Effects related to air pollution	Exposure to outdoor and indoor air pollutants and allergens Asthma and other respiratory diseases Heart attack, stroke and other cardiovascular diseases Cancer
Effects of water- and food-borne contamination	Diarrhea and intoxication caused by chemical and biological contaminants
Effects of exposure to ultraviolet rays	Skin damage and skin cancer Cataracts Disturbed immune function
Population vulnerabilities in rural and urban communities	Seniors Children Chronically ill people Low-income and homeless people Disabled people
Socio-economic impacts on community health and well-being	Loss of income and productivity Social disruption Diminished quality of life Increased costs for health care Health effects of mitigation technologies

Note. Adapted from Nicholas & Breakey (2017: 608).

Climate change is the main challenge for the world's population, especially for children and adolescents because of their level of development and needs for welfare and protection. Spain is one of the European countries most vulnerable to climate change. The year 2016 was the fourth warmest year on record. In addition, during this year rainfall was reduced by 20% and the average temperature increased throughout the country. At the current rate of growth of

greenhouse gas (GHG) emissions, we could experience temperature increases of 5ºC by 2050. The impact of climate change on children and adolescents is occurring in key development areas such as health, education, access to water and sanitation, leisure and recreation, as well as access to goods and services. Impacts will vary according to area of residence, gender, age and income (UNICEF, 2017).

The impact of climate change can reduce economic growth, limiting poverty reduction and increasing the risk of food and nutritional insecurity in rural areas. On the other hand, in urban areas, climate change could lead to an increase in inequality. Five hundred millions of children live in areas at high risk of flooding and 160 million live in places where droughts are increasingly frequent and severe. Vector-borne diseases affect children more than adults and can have lifelong consequences, as well as food insecurity and malnutrition. The poorest children are most affected. They live on land that is more exposed and less protected from natural disasters, they have less economic and material means to deal with impacts and they have less information about future impacts linked to climate change than families with more resources. In addition, their voice is less taken into account by politicians in decision-making (UNICEF, 2017). Within our study, bearing in mind that nurses must have a holistic view of health, they will take into account climate change as it is affecting children's health, specifically their environmental health.

The World Health Organization (WHO) (2018) defines environmental health as “all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, and genetics”. Thus, this concept includes the direct pathological effects of chemicals, radiation, and certain biological agents on health and well-being, in addition to the physical, psychological and social effects, including environment in general (housing, urban development, land use, and transport) (Ferrís-i-Tortajada, Ortega-García, Aliaga-Vera, Ortí-Martín & García-i-Castell, 2002a; Landrigan et al., 2019; McDermott-Levy, Jackman-Murphy, Leffers & Jordan, 2019). Environmental factors that negatively affect health are often called environmental hazards (Leffers, Smith, Huffling, McDermott-Levy & Sattler, 2016). In this study we will mention environmental health by referring to the environmental hazards that nurses can prevent, treat or reduce.

The concept of sustainable development can be defined as “development that meets the needs of the present generation without compromising the needs of future generations” (Ortega-García et al., 2001; Ortega-García, Ferrís-i-Tortajada & Sanchéz-Solís-de-Querol, 2008). It is inspired by "equity" as an intergenerational, international and intertemporal principle. Policy designed to mitigate the potential harms of global climate change imposes costs and investments on the present generation to provide benefits for future generations (Ortega-García et al., 2001). The concept of sustainable development will be used in our study with reference to provide training to nurses to address environmental health by achieving the best use of available resources to maximize child health now and in the future.

It is estimated that in the next decade, extreme weather events increase as a consequence of climate change, and it will affect 175 million children every year. Today, however, we have two solid frameworks for global action with a clear impact on the promotion of national and local policies to combat climate change and in favour of sustainability, the Paris Agreement (COP 21) and the 2030 Sustainable Development Agenda (UNICEF, 2017).

In 1992, many countries in the world adopted the United Nations Framework Convention on Climate Change, and they committed themselves to achieving stabilization of GHG concentrations in the atmosphere and preventing "dangerous" human interference in the climate system. The signatory countries to the convention meet every year to follow up on the decisions taken and the outcome of these decisions at the Conferences of the Parties (COPs) (UNICEF, 2017). The last one was the COP 24 that took place in Katowice, Poland, in December 2018; it got three key messages, electromobility allowing for sustainable urban development, lead the change together with people, and sustainable forest management.

Agenda 2030 introduces new commitments in relation to the promotion of environmental sustainability and the fight against climate change, the eradication of inequality and violence, and the promotion of innovation or the transformation of consumption patterns, through 17 objectives. Agenda 2030 and the Paris Agreement (COP 21) complement and strengthen each other. The European Union is committed to reducing GHG emissions up to 40% by 2030 based on 1990 (United Nations, 2015).

The Paris Agreement marked a milestone in the recognition of the close link between climate change and children. Some of the key international organizations and institutions on children's issues, such as UNICEF and the United Nations Special Rapporteur on Human Rights and the Environment, have highlighted the enormous damage of the impacts of climate change

on children and their rights around the world. These organizations have highlighted the need to comply with at least the following key aspects of the Paris Agreement (2015):

- Incorporate child rights analysis into policies and measures
- Count on the opinion of specialised organisations
- Monitor the fulfillment of children's rights in the context of climate change
- Carry out risk assessments
- Effectively observe and measure children's environmental health
- Improve health care for children, especially the most vulnerable
- Take measures to reduce pollution
- Minimize children's exposure to environmental pollution
- Make available to the public accessible information on how climate change affects children and what can be done to minimize negative impacts
- Incorporate education and information on change and its impact on training curricula

The Ottawa Charter for Health Promotion states that the fundamental conditions for health care, peace, protection, education, food, economic availability, a stable ecosystem, sustainable resources, social justice and equity. One of the most important roles for nurses in the 21st century will be to raise awareness and disseminate the importance of these issues to the society, and to require regional, state and local governments to allocate sufficient resources to meet all these needs to the general population and especially to children (Ortega-García et al., 2001).

Children's rights are recognized by the Convention on the Rights of the Child that entered into force in 1990 after being adopted by the United Nations Assembly a year earlier. Organic Law 8/2015, of 22 July, and Law 26/2015, of 28 July, on Modification of the System for the Protection of Children and Adolescents, establishes a Spanish legal framework.

Apart from this, there have been other initiatives to curb climate change, such as the Rio Declaration in 1992 and the Kyoto Protocol in 1997.

All these initiatives show that it is necessary to promote international interdisciplinary research and collaboration in order to develop policies that combat the adverse effects of climate change on health (Ortega-García et al., 2001). Research on the health effects of chemical pollution is needed to better understand the causes of non-infectious diseases and, hopefully, to

control how hazardous chemicals are removed or replaced with safer alternatives (Del-Río-Paredes, 2005).

CHAPTER 2 THEORICAL FRAMEWORK

After introducing the importance of climate change and environmental health for the nursing profession, we will frame the children´s environmental health and the competencies that nurses need in this area and how to achieve them.

2.1. Children´s Environmental Health

Children's health is affected by climate change by several factors that will be described below.

2.1.1. Children's Vulnerability to Environmental Factors

Children are the most vulnerable group in the population to exposure to environmental risk factors because of their immaturity, psychosocial dependence, and in addition the lack of positive stimuli and communication in the first three years of life will negatively determine the development of physical, mental and social habits (Ferrís-i-Tortajada et al., 2002b; Leffers et al., 2016; McBridge, 2016; Ortega-García et al, 2001; Zayas-Mujica & Cabrera-Cárdenas, 2007). They experience greater exposures to environmental health hazards of two to five times that of an adult (Leffers et al., 2016).

Infants and young children are exquisitely sensitive to environmental pollution, especially during windows of vulnerability in early development. Pollution exposures in infancy and early childhood can result in lasting injury to cells and tissues that increases risk of disease in childhood and can also reverberate across the life span. A great danger of pollution exposure in early life can undermine efforts to enhance children's development though improved nutrition, early learning and better health care (Landrigan et al., 2019).

Progressive and excessive industrialization is generating environmental pollution of the air, land, and aquatic ecosystems. Currently, more than 110,000 chemical compounds pollute natural ecosystems, both locally and globally. These substances pollute the soil and the food, water, and air that we ingest, drink, and breathe daily (Del-Río-Paredes, 2005; Ortega-García et al., 2008). More than two-thirds of children's health is threatened by environmental risks in their homes, where they learn and play (Ferrís-i-Tortajada et al., 2002b; Ortega-García et al, 2008).

Specifically, air, water, soil, and toxic chemical pollution were responsible for 940,000 deaths in children. Most were due to respiratory and gastrointestinal diseases caused by polluted air and water (Landrigan et al., 2019).

In industrialized countries, asthma mortality is three times higher than 20 years ago, despite the advances in pharmacology and hospital care that have taken place during this period of time. The paediatric population, although it represents only 20-25% of the total number of people, includes 40-45% of all asthma cases (Ferrís-i-Tortajada et al., 2002a), the estimated overall worldwide prevalence of current asthma is 11.70% among children six to seven years old and 14.10% among those 13 to 14 years old (George, Bruzzese & Matura, 2017).

More than 40% of the global disease burden attributed to environmental risk factors affects children under the age of five, who represent only approximately 10% of the world's population (Zayas-Mujica & Cabrera-Cárdenas, 2007). Children under five are particularly vulnerable, this age group accounts for more than 88% of the diseases caused by climate change (UNICEF, 2017), and up to 56% of all deaths attributable to domestic pollution (Del-Río-Paredes, 2005). Physical, chemical, and biological hazards in the environment are responsible for 26% of all deaths in children under the age of five years, nearly 1.5 million deaths worldwide. This includes road accidents, ultraviolet and ionizing radiation, noise, electromagnetic fields, psychosocial risks, built environments, agricultural methods and man-made climate and ecosystem change, as well as pollution (Landrigan et al., 2019).

These data illustrate the particular vulnerability in early human development that have no counterpart in adult life. Children are particularly vulnerable due to physiological, biological and social aspects of childhood:

1. Due to their increased energy and metabolic consumption, children breathe more air (given that their respiratory rate is higher), eat more food and drink more water per kilogram of weight than adults, and therefore they have proportionately greater exposures to environmental pollutants (Ferrís-i-Tortajada et al., 2002a, 2002b; Gavidia, Pronczuk & Sly, 2009; George et al., 2017; Landrigan et al., 2019; Ortega-García et al. 2001, 2008; UNICEF, 2017; Zayas-Mujica & Cabrera-Cárdenas, 2007).
2. Their organ systems are anatomically and functionally more immature, hindering the absorption, metabolism, detoxification and excretion of contaminating chemical substances; presenting rapid changes in growth, variations in organic and tissue immaturity, and quantitative and qualitative deficits in their immune system (Ferrís-i-

Tortajada et al., 2002a, 2002b; George et al., 2017; Landrigan et al., 2019; Leffers et al., 2016; Ortega-García et al. 2001, 2008; Zayas-Mujica & Cabrera-Cárdenas, 2007). The respiratory system is particularly vulnerable to adverse environmental exposures due lung development is an ongoing process, with most of the development occurring postnatally, and not being complete until 18 to 20 years of age; the developing lung is very susceptible to damage when exposed to environmental pollutants. In addition, children have smaller lungs and airway passages, and when inflammation occurs because of exposure to inhaled agents, inflammation can significantly block airflow (Gavidia et al., 2009; George et al., 2017; UNICEF, 2017).

3. Typical patterns of behaviour (social and recreational activities in the open air, hand-to-mouth contact, poor hygiene, etc.) during childhood facilitate greater accessibility and penetrability to pollutants, alongside children's inexperience to protect themselves (Ferrís-i-Tortajada et al., 2002a, 2002b; Gavidia et al., 2009; George et al., 2017; Ortega-García et al. 2001, 2008; UNICEF, 2017; Zayas-Mujica & Cabrera-Cárdenas, 2007).
4. In addition to the common route of inhalation exposure, children have unique routes of exposure including placental, dermal and non-nutritional ingestion that increase their exposure to sedimentary air pollutants (Gavidia et al., 2009; Leffer et al., 2016). Approximately 20-80% of dietary exposures come from hand to mouth behavior (Leffers et al., 2016).
5. Children have many more potential years of life ahead of them, they can develop medium and long term effects from chronic exposures in low doses of environmental pollutants (Landrigan et al., 2019; Leffers et al., 2016; Ortega-García et al., 2008; UNICEF, 2017).
6. Children do not have decision-making power in relation to the environmental issues that affect them more seriously than adults and that irreversibly affect their future habitats (Ortega-García et al., 2008; UNICEF, 2017).

The different phases of cell development can be altered by exposure to chemicals, causing long-term dysfunctions. It is precisely during childhood that the cell growth is most relevant and therefore the risk of health effects derived from environmental factors increases. The impact of a particular exposure will depend, in part, on the stage of the child's development at which the exposure occurs and his or her individual susceptibility (Del-Río-Paredes, 2005). The most vulnerable stages of childhood are:

- Development of germ cells: These can be damaged during their development in the fetus, in childhood and during adult life. Chemical substances that damage cells can impair adult fertility and lead to congenital problems for offspring (Del-Río-Paredes, 2005).
- Embryonic and fetal development: Due to the complexity and speed of development and the high rate of growth in the prenatal period, this stage of development is more vulnerable to environmental exposure than any other (Del-Río-Paredes, 2005; Leffers et al., 2016). There is growing evidence of the adverse effects of prenatal exposure to air pollution. Harmful effects have been shown in increased infant mortality, low birth weight, impaired lung development, increased respiratory morbidity and early alterations in immune development. Induction of specific processes or interaction with immune cells in the pregnant mother or fetus may also be possible consequences. Other indirect effects could be oxidative stress and inflammation, with consequent hemodynamic alterations resulting in decreased placental blood flow and reduced transfer of nutrients to the fetus. The mechanisms of production of these effects are direct particle toxicity due to particle displacement through tissue barriers or particle penetration through cell membranes in placenta (Leffers et al., 2016; Proietti, Roosli, Frey & Latzin, 2013; Sánchez-Sauco, 2017).
- Early childhood: The major structures of the brain and other systems continue to develop throughout childhood. The immune system develops extensively during childhood. Inadequate development of the immune system can cause allergies and autoimmune diseases throughout life (Del-Río-Paredes, 2005).
- Puberty: Sexual maturation is accompanied by complex interactions between the central nervous system and hormone-releasing organs, which can be affected by environmental factors (Del-Río-Paredes, 2005; Leffers et al., 2016).

During the different morphological and biological stages of child development, children may have different sensitivity to xenobiotic exposure. Children may metabolize a xenobiotic differently than a healthy adult depending on the route, timing, dose and duration of exposure. Many drugs and xenobiotics cross the human placenta, often by passive diffusion, and cause deleterious effects. Metabolic activity of the placenta can transform xenobiotics into severe toxicants. Children, especially neonates and infants in the first six months of life, may be particularly vulnerable to the effects of chemicals due to their immature metabolism and diminished or absent ability to detoxify and eliminate xenobiotics. Until the age of three and during puberty, children may absorb xenobiotics more fully than adults as they grow and develop rapidly (Zayas-Mujica & Cabrera-Cárdenas, 2007).

By sex, girls are the most vulnerable. The place of residence also determines the impact of climate change on children and adolescents. In Spain, coastal dwellers are especially vulnerable to rising sea levels, whereas inland heat waves will be more intense and more frequent, especially in the Mediterranean area (UNICEF, 2017).

2.1.2. Adverse Effects on Children´s Health

The WHO estimates that approximately one third of the disease burden in developing countries is attributable to modifiable environmental factors, including indoor and outdoor air pollution, unsafe water, inadequate sanitation, and hygiene (Etzel, 2015).

In 2003, the INMA - *Infancia y Medio ambiente* (Childhood and Environment) project was set up. It is a Spanish national network of birth cohorts aimed at assess the health impacts of prenatal and postnatal environmental exposures on children (Gascon et al., 2017). More of this project should be developed and other projects like this, because there is not still enough evidence about all the pollutants that affects the children´s health (Gascon et al., 2017; Vrijheid, Casas, Gascon, Valvi & Nieuwenhuijsen, 2016).

Since now, we know that the adverse impacts on children's health caused by an increase in the concentration of carbon dioxide are direct (acid precipitation, exposure to thermal stress, worsening global air quality and pathological incidents caused by extreme temperatures) and indirect (diseases transmitted by insects, water and psychological diseases) (Ortega-García et al., 2001):

2.1.2.1. Acid Precipitations

It is the result of the accumulation of sulphur and nitrogen oxides in the atmosphere. The main source of sulphur oxides is the combustion of fossil fuels, most of which are used to produce electricity (Galdó-Muñoz, 2000).

Children breathe air, drink water and consume food contaminated by acid precipitations (Ferrís-i-Tortajada et al., 2002a; Galdó-Muñoz, 2000). It directly causes conjunctivitis, rhinitis, pharyngitis, laryngitis, tracheitis and acute and chronic bronchitis. Acid precipitations also increase and exacerbate asthmatic crises. Indirectly, it dissolves toxic metals (mercury, lead, aluminum, copper, etc.) that are inert in the soil, passing them to vegetables, solubilizing them in water and contaminating animals. Later, through the food chain, they pass to humans

producing diverse gastrointestinal, renal, hepatic and neurological alterations. In weaker children they cause premature deaths (Ortega-García et al., 2001).

2.1.2.2. Thermal Stress

Heat waves cause increased mortality, secondary to the excessive demand for the cardiovascular system required for physiological refrigeration. Heat also aggravates some pre-existing diseases in vulnerable populations such as children. Mortality on hot days is predominantly associated with cardiovascular, bronchopulmonary and cerebrovascular disorders. It also causes significant morbidity, causing physical exhaustion, muscle cramps, syncope, fainting, gastrointestinal disorders and erythematous skin alterations (Ortega-García et al., 2001; UNICEF, 2017).

The risk of preterm birth during the last month of pregnancy increased by 20% if the mother are exposed to extreme temperatures two days before birth (UNICEF, 2017).

2.1.2.3. Worsening Overall Air Quality

Epidemiological studies show that exposure to different air pollutants is associated with increased incidence and severity of asthma, allergy, lung damage, impairs lung growth, pneumonia, chronic obstructive pulmonary disease (COPD) and other acute and chronic respiratory diseases in children and adolescents (Etzel, 2015; Landrigan et al., 2019; Vrijheid et al., 2016; Zayas-Mujica & Cabrera-Cárdenas, 2007). Even at relatively low levels of exposure, healthy individuals may experience chest pain, coughing and shortness of breath. Atmospheric pollution combined with heat accelerates and increases the production and concentration of photochemical oxidants in urban and rural areas, which irritate and damage nasal, oropharyngeal, laryngeal, tracheal and bronchopulmonary mucosa (Ortega-García et al., 2008). For example, smog-type air pollution from the combustion of sulphur fossil fuels, particularly coal, produces a concentration of total suspended particles greater than 100 mg/m^3, increasing respiratory symptoms; sometimes concentrations greater than 200 mg/m^3 are found, these concentrations are capable of altering lung function to a large extent (Galdó-Muñoz, 2000).

Worsening overall air quality also has a negative impact on digestive and dermatological allergies as well as hay fever (Ortega-García et al., 2001). Children will suffer an increase in allergies and respiratory diseases linked to the increase and intensity of the flowering season,

which will lead to higher pollen levels over a longer period of time in the year (Ortega-García et al., 2001; Rice et al., 2014; UNICEF, 2017).

A strong evidence base has emerged between air pollution, especially carbon monoxide, nitrogen dioxide, PM_{10} and $PM_{2.5}$, and greater risk of preterm birth and low birth weight (Vrijheid et al., 2016). Especially nitrogen dioxide used in gas appliances were associated with cognitive problems and attention deficit/hyperactivity disorder (ADHD) symptoms (Gascon et al., 2017).

2.1.2.4. Extreme Temperature Incidents

These incidents, also called "natural climatic disasters", cause a strong negative impact on health with significant loss of life and serious socio-economic repercussions (Ortega-García et al., 2001).

Some of these are the warming of sea water and the contrast with low temperatures at high atmospheric levels, which cause human losses due to drowning and morbidity due to trauma, infectious diseases, stress and adverse effects associated with social and environmental problems and forced emigration. Other such incidents include floods that destroy food supplies and contribute to produce infectious diseases caused by the breakdown of sanitary infrastructures (drinking water pipes and sewage pipes). In addition, they could release dangerous chemicals by overflowing or breaking industrial reservoirs where toxic materials are stored and treated, contaminating water, plant and animal food (Ortega-García et al., 2001).

2.1.2.5. Diseases Transmissible by Insects

Globalization and environmental changes are recognized as the significant drivers of these vector borne diseases. The big amount of travel movements and trade help to spread diseases through a dense network of air traffic and navigation routes. It facilitates the arrival, establishment and spread of invasive pathogens in new geographical destinations, including dengue virus, malaria, chikungunya virus, and West Nile virus (Medlock & Leach, 2015; Semenza, 2015).

Greenhouse conditions can help to spread diseases typical of warmer countries to cooler countries. The most important vector-borne diseases in our Mediterranean environment that are expected to increase due to climate change are leishmaniosis and Lyme disease (Ortega-García et al., 2001).

2.1.2.6. Waterborne Diseases

Some environmental diseases are transmitted by freshwater or seawater.

2.1.2.6.1. Freshwater

Many gastrointestinal diseases are caused by microorganisms that contaminate fresh water such as bacteria (Salmonella, Shigella and Campylobacter), viruses (rotavirus and enterovirus) and protozoa (Giardia Lamblia, Toxoplasma and Cryptosporidium) (Ortega-García et al., 2001). Other contaminants currently present in water, especially from wells, are pesticides and chemicals. These can cause diarrhea and dehydration (Leffers et al., 2016; Zayas-Mujica & Cabrera-Cárdenas, 2007).

2.1.2.6.2. Seawater

Excessive heating of seawater increases the growth of toxic organisms such as algae, which initially affect fish and secondarily people, producing intoxications with digestive and neurological disorders (Ortega-García et al., 2001).

2.1.2.7. Psychosocial Effects

In our century, the environment is not only a transporter of toxic substances, but it also acts indirectly on health by interacting with other social conditions. For example, it produces some subtle symptoms, such as headaches, nausea, eruptions, hyperexcitability, irritability, sleep disorders, depressive tendencies and stress (Ortega-García et al., 2001).

2.1.3. Environmental Factors in Chronic Pathologies

Some of the most important chronic respiratory, neoplastic and neurological pathologies are associated with environmental pollutants (Ferrís-i-Tortajada et al., 2002a; Ortega-García et al., 2008):

2.1.3.1. Respiratory Pathologies

More than 60% of diseases associated with respiratory infections are linked to pollution exposures. External pollutants such as sulphur dioxide, ozone, nitric oxide, carbon monoxide and volatile organic compounds come mainly from emissions from cars and power stations, from the open burning of solid waste and from the construction and related activities (Zayas-Mujica & Cabrera-Cárdenas, 2007).

Although oxygen consumption is a physiological factor, it is affected by activity levels and age, so the lower the body weight and age of children, the more chemicals present in the atmosphere and air pollution affect them, potentially leading to airway obstruction (Zayas-Mujica & Cabrera-Cárdenas, 2007). Allergic processes due to domestic and external pollution are causing major children's health problems (Ferrís-i-Tortajada et al., 2002a).

Asthma is essentially a developmental disease, in which the normal development of the respiratory and immune systems is altered by the impacts of environmental exposures, acting on underlying genetic predispositions. Air pollution, both outdoor and domestic, has been identified as a potential risk factor for its initiation, induction and exacerbation. For example, in The United States, asthma affects almost five million people under the age of 18, and it is the main chronic disease that causes school absenteeism. Each year more than 150,000 children need to be hospitalized and more than 600 die from this cause. A dramatic increase in asthma hospitalizations of children living in large cities and particularly in suburbs has been documented (Ferrís-i-Tortajada et al., 2002a).

In addition, exposure to air pollution in early human development, especially exposure to fine particulate pollution can be extremely deleterious to children's health and development. Sometimes, autism could be caused (Leffers et al., 2016). Maternal exposure to particulate pollution during pregnancy can injure the developing fetal brain and decrease children's intelligence. Air pollution exposure in pregnancy also increases risk for prematurity and low birth weight (Landrigan et al., 2019; Leffers et al., 2016; Zayas-Mujica & Cabrera-Cárdenas, 2007).

Some of the main domestic, school and external contaminants are discussed below.

2.1.3.1.1. Domestic Pollutants

Children spend most of their time indoors, which means that their main exposure to environmental pollutants comes from breathing the indoor air in their homes (Ortega-García et al., 2008). Ninety percent of rural households in low-income countries use biomass fuels for cooking or heating. The smoke contains particulates, carbon monoxide, nitrogen oxides, sulfur oxides, benzene, formaldehyde, and polycyclic aromatic hydrocarbons. Indoor particle concentrations range from 10 $\mu m/m^3$ to 2,000 $\mu g/m^3$ (much higher than the WHO air quality guidelines), they are produced by burning biomass fuels (Etzel, 2015).

Floor is an important microenvironment for infants and toddlers, who spend a long time in the crib or crawling at ground level. The layer of air close to the ground below 40 cm is a

major source of toxics. Heavy particles from environmental tobacco smoke, radon, pesticides, volatile organic compounds, formaldehyde from carpets or new furniture reach the highest concentrations at this point, exposing toddlers to the highest concentrations of toxins or their metabolites (Ortega-García et al., 2008).

Exposure to domestic pollutant doubles the risk of pneumonia. A 36% of lower respiratory infections are attributable to solid fuels and 1% of all respiratory infections to air pollution (Ferrís-i-Tortajada et al., 2002a; Gavidia et al., 2009). In industrialized countries, tobacco smoke plays the most important role in the production of acute respiratory infections. Acute lower respiratory infections and pneumonia represent the most important cause of death in children under five years of age in the world (Gavidia et al., 2009).

Poor indoor and outdoor air quality is closely related to allergic and asthmatic pathology, as well as an increase in other respiratory pathologies, such as upper respiratory infections, pneumonias and otitis (Ferrís-i-Tortajada et al., 2002a). Living in houses with poor temperature regulation systems affects children's school progress and emotional well-being, doubles the likelihood of respiratory problems, and even causes the youngest to have problems gaining weight, higher rates of hospital admissions and asthmatic symptoms (UNICEF, 2017).

The main pollutants in homes are the following (Ferrís-i-Tortajada et al., 2002a; Ortega-García et al., 2008):

2.1.3.1.1.1. Tobacco Smoke

Tobacco is the biggest air pollutant for our children. Cigarette smoke is more harmful to children's health than all air pollutants put together (Ortega-García et al., 2008). Half to two-thirds of the pediatric population live in domestic environments with at least one active smoker. They involuntarily breathe 4,000 chemicals in tobacco smoke, including carbon monoxide, nicotine, tar, formaldehyde and hydrogen cyanide. Most are respiratory irritants and 55 of them are classified as human carcinogens (Carrión-Valero & Pellicer-Ciscar, 2002; Etzel, 2015; Ferrís-i-Tortajada et al., 2002a; Ortega-García et al., 2008; Zayas-Mujica & Cabrera-Cárdenas, 2007). The 25% of these substances are inhaled by the smoker in the main stream, whereas the remaining 75%, from passive combustion, pass into the atmosphere in the secondary or side stream. Both currents have shown the presence of products harmful to health, although the concentration of certain toxic substances is higher in the secondary current that harms the passive smoker (Carrión-Valero & Pellicer-Ciscar, 2002; Gavidia et al., 2009).

Diseases caused by passive smoking in childhood may be a consequence of exposure before birth or after birth (Carrión-Valero & Pellicer-Ciscar, 2002). The main paediatric pathologies associated with passive smoking are classified according to their increased risk to health in:

- Group I: Intrauterine growth retardation, upper and lower respiratory infection, induction and exacerbation of asthma, chronic respiratory symptoms, conjunctivitis, rhinitis, cough, headache, nausea, eye irritation and otitis media (Carrión-Valero & Pellicer-Ciscar, 2002; Etzel, 2015; Ferrís-i-Tortajada et al., 2002a; Gavidia et al., 2009; Ortega-García et al., 2008; Sánchez-Sauco, 2017).
- Group II: Endocrine disruption of the newborn, deficits in cognitive and behavioural functions, exacerbation of cystic fibrosis, decrease in pulmonary function, bronchial hyperactivity, and alteration of lipid profile (Carrión-Valero & Pellicer-Ciscar, 2002; Ferrís-i-Tortajada et al., 2002a; Gascon et al., 2017; Ortega-García et al., 2008; Sánchez-Sauco, 2017).
- Group III: Sudden infant death syndrome, congenital malformations, bronchopulmonary cancer, oral cavity cancer, acute myocardial infarction, angina pectoris, lymphoblastic and acute myeloid leukaemia, central nervous system tumors, Wilms tumor, neuroblastoma, and bone and soft tissue sarcomas (Carrión-Valero & Pellicer-Ciscar, 2002; Etzel, 2015; Ferrís-i-Tortajada et al., 2002a; Ortega-García et al., 2008; Sánchez-Sauco, 2017).

Other pathologies have been described by Carrión-Valero and Pellicer-Ciscar (2002), such as higher rate of school absenteeism and worse diet.

Exposure to tobacco smoke is one of the main risk factors for asthma and half of Spanish children are exposed to it daily in the family environment. Around 80% of persistent asthma cases are developed before the age of six are attributable to paternal smoking (Carrión-Valero & Pellicer-Ciscar, 2002).

2.1.3.1.1.2. Carbon Monoxide

It may be the best-known indoor air pollutant. Enclosed and poorly ventilated spaces can have high carbon monoxide values. As a result of incomplete combustion of carbon, heaters are the most frequent source of exposure, followed by stoves and cooking ovens that run on gas, coal or wood. Incomplete combustion due to poor maintenance and inadequate ventilation can

also greatly increase the concentration of carbon monoxide (Etzel, 2015; Ortega-García et al., 2008).

This gas is absorbed through the respiratory mucosa, passes quickly to the blood to combine with great eagerness to hemoglobin forming carboxyhemoglobin as it has an affinity 240-270 greater than oxygen to combine with the hemoglobin. Carboxyhemoglobin is incapable of transporting oxygen, producing hypoxemia and cellular asphyxia (Ortega-García et al., 2008).

Fetus is especially vulnerable because of: a) Greater affinity of fetal hemoglobin; and b) longer average time to elimination of carboxyhemoglobin. The infantile-juvenile population is also more susceptible to carbon monoxide toxicity due to its higher tissue and cellular metabolic rate (Ortega-García et al., 2008).

Symptoms of carbon monoxide poisoning range from headaches, dizziness, fatigue, nausea, vomiting, paleness, light-headedness, general malaise, dyspnea, palpitations, irritability, drowsiness, confusion, lethargy, coma and death when carboxyhemoglobin levels exceed 70% (Etzel, 2015; Ortega-García et al., 2008). In children, mild-moderate poisonings can present symptoms similar to flu (Ortega-García et al., 2008). But, children with higher exposures to carbon monoxide may have seizures, coma, or dysrhythmias (Etzel, 2015).

2.1.3.1.1.3. Mold Spores

The most common indoor molds are Cladosporium, Aspergillus and Alternaria. Molds require water and nutrients to grow. Water enters the home through leaking roofs and walls, or flooding. Nutrients can be cellulose objects such as wood, books or cardboard. The toxic effects of molds are caused by inhalation of mycotoxins through the respiratory tract (Ortega-García et al., 2008).

Two adverse effects caused by mold spores have been described: a) Allergic reactions and b) toxic effects. Some children exposed to molds have allergic effects that manifest as persistent upper respiratory symptoms such as rhinitis, sneezing, conjunctivitis and also coughing and wheezing (Ortega-García et al., 2008). Etzel (2015) described that mycotoxins can harm children's immune systems and lead to acute respiratory illness, gastrointestinal illness, tremors, and cancer. Seo, Choung, Chen, Lindsley and Kim (2014) showed that increased exposure to mold from humidity in the home may contribute to exacerbation of asthma symptoms; besides Gascon et al. (2017) showed that persistent dampness during early life significantly decreased the general cognitive development.

Aflatoxins are poisonous substances that occur as a result of mold growth on peanuts and corn. High levels of aflatoxin cause acute aflatoxicosis. Aflatoxins exposure during pregnancy results in poor growth in the child's first year of life (Etzel, 2015). Ochratoxin A, produced by some molds, is toxic to the kidneys. It is teratogenic, immunotoxic, genotoxic, mutagenic and carcinogenic (Etzel, 2015).

2.1.3.1.1.4. Volatile Organic Compounds

They are pollutants that evaporate from certain substances such as household cleaning products, adhesives, glues, paints or furniture varnishes. These products pass into the air and become trapped in the rooms of poorly ventilated buildings (Ferrís-i-Tortajada et al., 2002a; Gavidia et al., 2009; Leffers et al., 2016). Acute exposure to these substances causes eye, nasal, pharyngeal and bronchial irritation, non-specific dermatitis, headache, nausea and vomiting and triggers asthma attacks. Chronic exposure to some volatile organic compounds such as benzene and vinyl chloride can cause some cancers, bladder cancer, leukemia and lymphoma (Ferrís-i-Tortajada et al., 2002a; Landrigan et al., 2019).

Formaldehyde, one of the components included in this group of substances, is a colourless gas used in the wood industry (conglomerates, boards, plywood, etc.), paints, coatings, cosmetics, insulating materials, and so forth. It is also released in the combustion of wood, kerosene, natural gas, automobile engines and cigarettes. One of the problems with this compound is that ventilation does not purify the air (Ferrís-i-Tortajada et al., 2002a; Galdó-Muñoz, 2000). It causes irritant symptoms in the ocular and respiratory mucous membranes, triggering asthmatic crises in allergic people. In addition, it is recognized as a human carcinogen. In children it causes the development of hives and other dermatological allergic signs (Ferrís-i-Tortajada et al., 2002a).

2.1.3.1.1.5. Nitrogen Oxide

It is produced by the combustion of fossil fuels (coal stoves, diesel, natural gas, non-electric stoves, etc.) and by tobacco smoke. It is a very powerful respiratory irritant, triggering and aggravating asthmatic crises and other respiratory diseases (Ferrís-i-Tortajada et al., 2002a).

2.1.3.1.1.6. Allergens

They are the classic agents that cause or aggravate domestic asthmatic crises such as dust mites, cockroaches, pet dander, pollens, fungal spores, viruses and bacteria. They also cause

allergic digestive and dermatological manifestations (Eztel, 2015; Ferrís-i-Tortajada et al., 2002a), and sometimes acute pulmonary hemorrhage in infants (Etzel, 2015).

2.1.3.1.2. School Pollutants

Children spend about 40 hours a week in schools and daycare centers. Schools must be safe places for our children to learn, play and live together free from physical environmental hazards (extreme temperatures, loud noises, high voltage power lines, telecommunication antennas, etc.), chemical hazards (tobacco smoke, pesticides, diesel engines in school transport, asbestos, lead, persistent organic compounds, etc.), and biological hazards (germs, viruses, parasites, etc.). At the same time, the content (education, instruction and learning) must include as priority tasks the knowledge of environmental pollutants and their adverse effects on natural ecosystems and human health. These topics should be introduced early and maintained during all phases of cognitive and behavioural maturation from early childhood to puberty (Ortega-García et al., 2008).

School and kindergarten are a special source of concern for parents about the various aspects of toxic exposure in school buildings. An unhealthy school environment consisting of mold, vermin, dust, chemicals from cleaning supplies, poor air quality, or other such hazards that can trigger asthma symptoms in students and staff. Healthy schools can reduce asthma almost 40% and upper respiratory infections nearly 70% by adopting best practices to improve indoor air quality whereas also reducing absenteeism and increasing productivity (Leffers et al., 2016).

Many of the exposures during the school stage derive from an advanced age of the school building, and explain the presence of asbestos and other materials used in the construction of buildings in the past. But sometimes they are in unsafe areas: Old slopes of avenues, next to large highways or roads, located near highly toxic industrial activities, under high voltage power lines, over soil or old industrial sludge rich in arsenic, lead and other heavy metals. In addition, classrooms are usually fumigated with pesticides during the summer and there are many products that can be used in craft classes, such as various types of paint, among others (Ortega-García et al., 2007, 2008).

The combination of these risk factors in the school environment can produce symptoms such as itchy eyes, headaches or discomfort, which often affect groups of students exposed to low doses of pollutants present in buildings with poor air quality. These symptoms usually improve on weekends (Ortega-García et al., 2007, 2008). Another problem is the ultraviolet

radiation to which children are exposed. Shade areas in schools need to be increased and gymnastics schedules need to be moved out of peak hours (Ortega-García et al., 2007, 2008).

2.1.3.1.3. External Air Pollutants

The main urban air pollutants are ozone, carbon monoxide, sulphur compounds and nitrogen oxides (Ferrís-i-Tortajada et al., 2002a; Gavidia et al., 2009).

2.1.3.1.3.1. Ozone

It is a major component of urban smog and a potent irritant that can synergistically increase a child's reaction to other air pollutants and pollens (Gavidia et al., 2009). Tropospheric ozone is formed by photochemical reactions from nitrogen oxides and volatile organic compounds. Children are especially vulnerable to the effects of ozone and particulate matter. Ozone is constantly associated with worsening bronchial asthma and also with reduced lung function in non-asthmatic and non-allergic children (Ferrís-i-Tortajada et al., 2002a; Galdó-Muñoz, 2000).

Ozone increases on sunny and cloudless days, as well as at high temperatures. In children it can exacerbate pre-existing respiratory pathologies, since ozone is a respiratory irritant that produces bronchial inflammation and overreactivity. Ozone has also been associated with a deterioration in asthma control (Rice et al., 2014). In addition, an increase in the mass of adipose tissue due to childhood obesity produces greater susceptibility to ozone-associated pulmonary infections (Calderón-Guzman, Hernández-García & Barragán-Mejía, 2011).

In summer, due to weather conditions, the highest atmospheric concentrations of ozone and particles are usually reached. At that time, children spend more time outdoors and engage in more vigorous physical activities, which result in greater exposure and respiratory absorption of this air pollutant. Whereas in adults it causes only slight respiratory difficulties, in children the short, medium and long term repercussions are more important (Ferrís-i-Tortajada et al., 2002a).

2.1.3.1.3.2. Carbon Monoxide

This gas is produced by the deficient combustion of substances such as gasoline, kerosene, coal, oil, tobacco or wood. Vehicles with the engine running also fire carbon monoxide. Reduced infant lung function is a known risk factor in the development and worsening of asthma and the subsequent development of COPD (Gavidia et al., 2009).

2.1.3.1.3.3. Sulphur Compounds

Industries that manufacture or use acids may emit sulphur dioxide, which contributes to the formation of acid rain (Gavidia et al., 2009). Respiratory health problems related to this compound are bronchoconstriction in asthmatics, decreased lung clearance and increased infections such as bronchitis and pneumonia (Gavidia et al., 2009).

2.1.3.1.3.4. Nitrogen Oxides

This compound is mainly formed as a by-product in high-temperature combustion processes, such as in motor vehicles and power plants. It is a corrosive substance to the skin and respiratory tract, causing severe skin redness and burns (Gavidia et al., 2009).

Prolonged exposure to nitrogen oxide can affect the immune system and lung growth, resulting in reduced resistance to infection and irreversible changes in lung tissue. It also leads to asthma attacks, chronic cough and bronchitis. It has also shown that fine particles in diesel emissions can intensify allergic and inflammatory responses and facilitate the development of new allergies (Gavidia et al., 2009). Recent cohort studies suggest a positive association of otitis with nitrogen oxides (Ferrís-i-Tortajada et al., 2002a; Gavidia et al., 2009).

2.1.3.2. Neoplastic Diseases

All tumors are caused by the variable combination of two types of determinants, the genetic or endogenous and the environmental or exogenous. Some authors (Berbel-Tornero, Ferrís-i-Tortajada, Donat-Colomer, Ortega-García & Verdeguer-Miralles, 2006) assign a percentage of only 4-15% of childhood tumors to genetic risk factors, whereas environmental carcinogens cause the remaining cases. Although the origin of the cancer is multifactorial, the influence of environmental carcinogens is fundamental and decisive. The period of action and latency is from several years to decades, so the pre-conception, gestational and postnatal periods must be taken into account in the emergence of pediatric cancers (Ferrís-i-Tortajada et al., 2002a).

The children are exposed to carcinogens through multiple routes or vectors of transmission such as air, water, food, drugs, skin contact and tobacco use (Ferrís-i-Tortajada et al., 2002a). Some of the environmental factors associated with cancers are the following:

2.1.3.2.1. Indoor Tobacco Smoke

The pediatric population, especially during the first decade of life, is exposed to environmental tobacco smoke in multiple places (homes, nurseries, schools, school buses, bars, restaurants, etc.). They are passive smokers who inhale the 4,000 toxic substances contained in tobacco smoke, 55 of which are classified as carcinogenic. Passive smoking is associated with neoplasms such as acute leukemia, central nervous system tumors, neuroblastoma, Wilms' tumor, soft tissue tumor and bone sarcomas (Ferrís-i-Tortajada et al., 2002a).

2.1.3.2.2. Radon

Radon is a colourless, odorless, tasteless gas that originates from the disintegration of uranium contained in the soil and rocks of the earth's crust. Through the soil it penetrates through fissures and other openings in buildings in the domestic environment. In certain geographical areas, indoor radon concentrations are higher than those tolerated in mines (Galdó-Muñoz, 2000; Tong et al., 2012).

Radon disintegrates into other radioactive particles that can be inhaled and retained in the mucosal cells of the respiratory tract and lung parenchyma (Etzel, 2015; Ferrís-i-Tortajada et al., 2002a; Galdó-Muñoz, 2000). Small amounts of radon damage the bronchopulmonary parenchyma and over time increase the risk of lung cancer (Ferrís-i-Tortajada et al., 2002a; Tong et al., 2012). In addition, epidemiological studies have shown that exposure to radon in the domestic environment is associated with leukemia, central nervous system tumors and malignant lymphomas in children; the cumulative effects of radon exposure are those that increase the risk of leukemia (Etzel, 2015; Tong et al., 2012).

2.1.3.2.3. Asbestos

It is a fibrous mineral that was widely used in building materials until recently, such as roofing and cladding plates, pipe and boiler insulation, floor tiles, roofing panels, shelters and waterproofing joints (Ferrís-i-Tortajada et al., 2002a).

It is still present in schools and other public buildings as well as in structures of domestic residences. The children of some workers are exposed to asbestos dust through clothing and shoes. And it is associated with pulmonary and abdominal mesothelioma and lung cancer (Landrigan et al., 2019; Ferrís-i-Tortajada et al., 2002a). It is currently estimated that 1,000

children will die prematurely from school exposure to asbestos in the next 30 years (Ferrís-i-Tortajada et al., 2002a).

2.1.3.2.4. Ultraviolet Radiation

Overexposure to solar ultraviolet radiation can damage the skin of children to a greater extent than that of adults because of the thinner keratin layer, fewer melanocytes, less antioxidant capacity in the dermal basal cells and their longer overall time outdoors. Before the age of 18, more than half of the expected ultraviolet radiation is absorbed over the course of an average life span (75-80 years). In recent years, this type of radiation is increasing due to damage to the stratospheric ozone layer by the emission of chlorofluorocarbonated gases in industrialized countries (Ferrís-i-Tortajada et al., 2002a; Zayas-Mujica & Cabrera-Cárdenas, 2007).

Ultraviolet radiation A and B are carcinogens associated with basal cell carcinoma, squamous cell carcinoma and malignant melanoma. Children who during the first 10-15 years of life suffer excessive sunburn present a risk three times greater than expected to develop malignant melanoma in adulthood (Ferrís-i-Tortajada et al., 2002a; Galdó-Muñoz, 2000; Zayas-Mujica & Cabrera-Cárdenas, 2007).

2.1.3.2.5. Electromagnetic Radiation

Electromagnetic radiations are produced by power lines and magnetic fields induced by household appliances. These have been accused of increasing the risks of cancer in children (Etzel, 2015; Galdó-Muñoz, 2000), especially leukemia (Zayas-Mujica & Cabrera-Cárdenas, 2007). Acute effects of overexposure to ionizing radiation include acute radiation sickness (nausea, vomiting, diarrhea, declining white blood cell count and thrombocytopenia), epilation (loss of hair), and death (Etzel, 2015).

2.1.3.2.6. Radioactive Isotopes

Several studies have concluded that children are generally more sensitive than adults to radiation for 25% of cancers, including leukemia, thyroid, skin, breast and brain cancers. Having repeated computed tomography scans puts children at greater risk for leukemia and solid cancers. Exposure in the uterus may also increase the risk of cancer, in addition to causing problems in the development of the central nervous system (Kamiya et al., 2015).

2.1.3.2.7. Hazardous Waste

Hazardous waste produces carcinogenic and non-carcinogenic toxic substances that contaminate the environment in places close to storage. Carcinogenic agents include various organic compounds (trichloroethylene, benzene, dioxins, furans, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, etc.) and metals (lead, cadmium, arsenic, chromium, cobalt, nickel, etc.).

Children from marginal populations living in areas close to deposits or dumping of hazardous waste are exposed to higher concentrations of carcinogens through the air, water and food they consume (Etzel, 2015; Ferrís-i-Tortajada et al., 2002a). And children living in towns where primitive e-waste recycling occurs may have high blood levels of lead and cadmium (Etzel, 2015).

2.1.3.3. Neurological Diseases

Neurotoxic substances are chemical compounds which, depending on the period of action and the doses, can affect the morphological development of the brain and interfere with the functions of the nervous system. They can have negative repercussions in the level of intelligence, capacity of language and attention, behaviour, state of mind and cause social problems. At very high doses, neurotoxins produce stupor, coma, convulsions, respiratory paralysis and death (Ferrís-i-Tortajada et al., 2002a).

A wide variety of chemicals are toxic especially in the developing brain and generate neurological and neurocognitive diseases. These neurotoxins can directly injure nerve cells or interfere with hormones, neurotransmitters or other growth factors (Ferrís-i-Tortajada et al., 2002a). The central nervous system of children is particularly vulnerable to the effects of the environmental concentration of heavy metals. Heavy metals are captured by organisms and can accumulate in tissues (Galdó-Muñoz, 2000). Some widely used chemicals are known to be toxic to children's development. Hundreds more have never been tested for safety or toxicity and their possible dangers to children's health and development are not known (Landrigan et al., 2019). The main neurotoxins are the following:

2.1.3.3.1. Heavy Metals

Heavy metals are among the most dangerous neurotoxins. The most important are the following.

2.1.3.3.1.1. Lead

Lead accumulates in the brain and central nervous system (Galdó-Muñoz, 2000; Leffers et al., 2016). Elevated blood lead levels, particularly before the age of six, are associated with attention deficits, poor school performance, language difficulties, decreased IQ, hyperexcitability, aggressiveness and criminal and antisocial behaviours (Etzel, 2015; Ferrís-i-Tortajada et al., 2002a; Landrigan et al., 2019; Vrijheid et al., 2016; Zayas-Mujica & Cabrera-Cárdenas, 2007). Adverse effects on learning and intellectual development are being observed at plasma levels recently considered safe (Ferrís-i-Tortajada et al., 2002a), blood lead concentrations below 10 µg/dL (Etzel, 2015).

Lead concentrations peak around two years of age. The risk increases because the intestinal absorption of lead is higher in children than in adults (Galdó-Muñoz, 2000). In addition, children are at greater risk of ingestion of environmental lead by putting hands and objects in their mouths (Zayas-Mujica & Cabrera-Cárdenas, 2007). Children also may be exposed from the use of lead ore in eye cosmetics and from lead in ceramic dishes or paint. Besides, children may be exposed from backyard cottage industries, or they also may be exposed from living or playing near areas where mining occurs (Etzel, 2015).

2.1.3.3.1.2. Mercury

Like lead, mercury accumulates in the brain and central nervous system (Galdó-Muñoz, 2000). Of the different kinds of mercury, organic mercury, particularly methylmercury, is the most dangerous to the developing brain. Exposure to high doses causes severe disabilities such as mental retardation and cerebral palsy; whereas exposure to low doses can lead to problems with attention, memory and language, like reduction of IQ and shortening of attention span (Gascon et al., 2017; Landrigan et al., 2019; Vrijheid et al., 2016; Zayas-Mujica & Cabrera-Cárdenas, 2007).

Fetal exposure to methylmercury causes mental retardation, visual disturbances and gait disturbances. Even point exposures, such as those resulting from maternal fish consumption, are associated with language, attention and memory problems that may be permanent (Etzel, 2015; Ferrís-i-Tortajada et al., 2002a; Magnus, 2017). Prenatal exposure is also associated with the presence of high blood pressure during childhood (Zayas-Mujica & Cabrera-Cárdenas, 2007).

In the fetal and infantile-juvenile periods, the main sources of mercury exposure are the diet with contaminated food intake, mainly through fish and shellfish (Etzel, 2015; Zayas-Mujica & Cabrera-Cárdenas, 2007). The highest level of mercury are found in the following seafood: Marlin, orange roughy, tilefish, swordfish, shark, king mackerel and tuna (Leffers et al., 2016). Other sources could be small-scale gold-mining activities, and cosmetic and toiletries (Etzel, 2015).

A clear example is chronic mercury poisoning, which seriously affects the neurological health of Eskimo children in northern Alaska and Canada through the consumption of contaminated fish, which is one of the traditional foods in their ancestral diet (Ferrís-i-Tortajada et al., 2002b).

2.1.3.3.1.3. Manganese

In spite of being an essential component for the organism (since a deficit alimentary intake can cause irregularities in the connective tissue, cartilages and bones), excessive and prolonged inhalation can cause alterations in the central nervous system, such as hyperactivity, learning disorders and loss of IQ (Landrigan et al., 2019; Ferrís-i-Tortajada et al., 2002b).

2.1.3.3.1.4. Cadmium

Cadmium is a heavy metal found in the earth's crust and diffuses into the environment through both natural processes and human activities such as burning fossil fuels, incinerating waste, smelting processes and the use of phosphate fertilizers. Exposure to cadmium in children occurs through food, breast milk or tobacco smoke. Cadmium is known to be carcinogenic, but some recent studies have suggested that cadmium exposure may have adverse consequences on neurodevelopment and learning (Ciesielski, Weuve, Bellinger, Schwartz, Lanphear & Wright, 2012; Rodríguez-Barranco et al., 2004).

2.1.3.3.2. Tobacco Smoke

Children born to mothers who smoke during pregnancy have an increased risk of intelligence deficits, learning disabilities and attention deficits. In addition, children born to mothers passively exposed to tobacco smoke also have an increased risk of language and intelligence delay (Ferrís-i-Tortajada et al., 2002a).

2.1.3.3.3. Dioxins

Dioxins are found throughout the world in the environment and they accumulate in the food chain, mainly in the fatty tissue of animals. Human intrauterine exposure to dioxins leads to learning disabilities, IQ deficits, hyperactivity and attention deficit (Ferrís-i-Tortajada et al., 2002a), apart from wheeze and infections and reduced birth weight when mothers are exposed to them during the pregnancy (Magnus, 2017).

2.1.3.3.4. Polychlorinated Biphenyls

Its neurobehavioural effects have been widely studied in neonates and children. The mechanisms of this neurotoxicity have a direct and indirect brain effect by thyroid agonist and steroid modulation. Changes in dopaminergic and serotonin neurotransmitters have been reported, even with perinatal exposure, and negative association is reported between exposure and motor development and cognitive function in children (Zayas-Mujica & Cabrera-Cárdenas, 2007).

The routes of exposure are ingestion of contaminated food, inhalation and skin contact. Acute food poisoning contaminated with polychlorinated biphenyls (PCBs) was associated with fatigue, headache, dizziness, muscle weakness, and concentration and memory problems (Zayas-Mujica & Cabrera-Cárdenas, 2007), other author (Magnus, 2017) added symptoms like wheeze and infections.

Effects in exposed newborns include lower birth weight, hyperpigmentation, early onset of teething, deformed nails and hypertrophy of the gums. In childhood, there is also a decrease in IQ, health disorders and a higher incidence of behavioural problems. At an early age, prenatal PCBs exposure is linked in some studies to a variety of cognitive disorders, late maturation, behavioural problems and emotional effects (Gascon et al., 2017; Landrigan et al., 2019; Vrijheid et al., 2016; Zayas-Mujica & Cabrera-Cárdenas, 2007), language development problems and ADHD (Magnus, 2017).

In children exposed to polybrominated diphenyl ether (PBDE) were found decreasing mental development and attention deficit problems (Gascon et al., 2017).

2.1.3.3.5. Brominated Flame Retardants

Neurodevelopmental impairment with persisting loss of IQ and disruption of behaviour is associated with prenatal exposure to brominated flame retardants (Gascon et al., 2017;

Landrigan et al., 2019). Dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenyldichloroethylene (DDE) were showed the most dangerous in Vrijheid et al. (2016) and Gascon et al. (2017).

2.1.3.3.6. Hexachlorobenzene

This compound can be used in some fabrics and laboratories, and it is present in the air at room temperature. Exposures to hexachlorobenzene (HCB) had a statistically significant increased risk of having poor social competence and ADHD (Vrijheid et al., 2016).

2.1.3.3.7. Perfluoroalkyl Substances

Perfluoroalkyl substances (PFASs) are found in water polluted by factories. They are associated with neurodevelopmental problems (Vrijheid et al., 2016) and lower birth weight if the mother is exposed to them during the pregnancy (Magnus, 2017).

2.1.3.3.8. Pesticides

Children are especially vulnerable to pesticides. Most studies evaluating prenatal pesticide exposure observe a negative effect on mental development and increased attention problems, decreased IQ, and speech understanding problems in preschool and school children. The evidence for postnatal exposure is less consistent, although an increase in reaction time has been found in schoolchildren (Etzel, 2015; González-Alzaga et al., 2014, 2015; Sánchez-Sauco, 2017).

Exposure to organophosphate insecticides at low doses on critical days of embryonic development can cause hyperactivity, loss of IQ, behavioural disruption, changes in brain structure and function and permanent alterations in brain neurotransmitter levels (Ferrís-i-Tortajada et al., 2002a; Gascon et al., 2017; Landrigan et al., 2019).

In children in farming communities exposed to various pesticides, decreased memory, coordination and resistance capacity have been shown (Ferrís-i-Tortajada et al., 2002a). In addition, it is estimated that each year pesticides are responsible for approximately 100,000 deaths, with young children being most affected due to improper storage of pesticides and children's relentless exploration of their living space (Galdó-Muñoz, 2000; Zayas-Mujica & Cabrera-Cárdenas, 2007).

Chronic exposure to low doses of some pesticides may cause adverse effects such as central nervous system development problems, impaired immune system, endocrine destabilization or cancer. Children´s exposure occurs through breathing, drinking or eating, and through dermal route (Zayas-Mujica & Cabrera-Cárdenas, 2007).

Infants may also be exposed to concentrations of pesticides in breast milk. Some studies have shown a high embryotoxic and fetotoxic frequency, responsible for first-trimester abortions and fetal lesions at birth (Galdó-Muñoz, 2000).

2.1.3.3.9. Phthalates

Neurodevelopmental impairment with loss of IQ, behavioural disruption and increased risk of ADHD is associated with exposures to phthalates. They are added in fragrances or using in children toys (Gascon et al., 2017; Landrigan et al., 2019; Leffers et al., 2016; Sánchez-Sauco, 2017).

2.1.3.3.10. Bisphenol A

Bisphenol A (BPA) is an endocrine disruptor. It is capable of causing imbalances in the hormonal system at very low concentrations with possible health repercussions. It could be in plastic toys. Besides, other times its toxic effects are due to the consumption of food that has been contaminated by contact with materials containing this substance, such as cans or containers of very diverse kind (Vrijheid et al., 2016).

2.1.3.3.11. Solvents

Exposure during embryonic development to solvents contented in paints or cleaning products can cause a wide spectrum of pathologies, from congenital alterations to hyperactivity, attention deficits, decreased IQ, decreased memory capacity and learning problems (Ferrís-i-Torjada et al., 2002a).

2.1.3.3.12. Alcohol

Fetal exposure to small doses of alcohol, such as ingestion of an alcoholic beverage on critical brain development days, can lead to impulsive behaviour, memory and IQ deficits, poor school performance, and antisocial behaviour (Ferrís-i-Torjada et al., 2002a). Sánchez-Sauco (2017) showed teratogenic effects during pregnancy, microcephaly, loss of neurons,

synaptogenesis or glia defects that may cause memory/learning disorders mediated by apoptotic processes.

2.1.3.3.13. Arsenic

Food crops can take up arsenic from the soil. Arsenic also is found in some herbal remedies. Neurologic effects, cardiovascular and pulmonary disease, skin lesions, and diabetes are also associated with arsenic exposure from drinking water. After 20 or more years of exposure to high arsenic levels in drinking water, arsenic causes bladder, kidney, lung and skin cancers (Etzel, 2015).

2.1.3.3.14. Fluoride

Studies in human populations suggest that exposure to fluoride may adversely affect neurodevelopment, at concentrations used for fluoridation of drinking water. In the newborn, about 90% of the absorbed fluoride is retained in the bone system. This affinity decreases with age and stabilizes (Etzel, 2018; NurSusTOOLKIT Project, 2018).

2.1.4. Environmental Pollution and Infant Feeding

Diet in the early stages of life is related to states of health or disease in adulthood. Adequate nutrition in the early years prevents disease for the rest of our lives, in contrast, the intake of contaminated food can have health consequences in the short, medium and long term. The current production, harvesting, handling and distribution of food is determined by an economic dynamic, where the quality of what we eat or the context in which the food is produced do not matters too much, since what matters most is to make a profitable product (NurSusTOOLKIT Project, 2018; Winter, 2003).

The foods we consume may contain pesticide residues. Plastic food wrap may expose families to phthalates and BPA. High fat foods such as meat and dairy may contain chemicals that are lipophilic such persistent organic pollutants. Fish may be contaminated with mercury, a known neurotoxin (Leffers et al., 2016). Fumonisins are contaminants of cornmeal and cereals. Eating foods contaminated with fumonisins increases the risk of having a child with a neural tube defect and in children increase the risk of developing esophageal cancer during adulthood (Etzel, 2015).

Apart from this, many toxic chemicals are initially emitted into the atmosphere, so atmospheric pollution determines the degradation of the quality of water, soil and even of food (Zayas-Mujica & Cabrera-Cárdenas, 2007).

2.1.4.1. Food Additives

In order to ensure the safety of food additives, they must be harmless in themselves, contain no harmful components from their natural sources or from chemical reactions occurring during the manufacturing process. The acute, sub-acute or chronic toxicity of any substance likely to be used as an additive is therefore studied, together with its effects on reproduction, teratogenicity, carcinogenicity and mutagenicity. The ultimate objective of toxicity and safety studies of additives is to establish the maximum dose without harmful effects, which is translated into the acceptable daily intake or acceptable daily dose, which is the amount of additive, expressed in milligram of additive per kilogram body weight, that can be consumed over a prolonged period, or even a lifetime, without danger to health (León-Espinosa-de-los-Monteros, Rueda-Domingo, Castillo-Sánchez, Ceballos-Atienza & Fernández-Lloret, 2000).

The clinical manifestations secondary to an intolerance to the additives are fundamentally of dermal type, being the chronic urticarial the most frequent. Asthma due to additives is also a constant in the literature, as well as the existence of certain psychomotor disorders that may be triggered by the direct action of some dyes on the central nervous system (León-Espinosa-de-los-Monteros et al., 2000). Overactive behaviour in children is related to the ingestion of foods containing artificial condiments, dyes and salicylates (León-Espinosa-de-los-Monteros et al., 2000).

Monosodium glutamate is the most commonly used flavour enhancer. It has been associated with the presence of bronchial asthma, and the so-called Chinese restaurant syndrome, among other effects. In children, it can also lead to hypothalamic symptoms. Citric acid can cause cavities, local irritation or hives (León-Espinosa-de-los-Monteros et al., 2000).

2.1.4.2. Organic Food

Organic food is produced in accordance with European Community Regulations 834/2007 and 889/2008 that emphasize the protection of the environment and the control of the use of chemicals in crops and medicines in animal production. Organic food is generally grown without pesticides, synthetic fertilizers, use of antibiotics or growth hormones. Organic livestock feeds on

organically produced feed that is free of pesticides and animal by-products, has access to the open air, direct sunlight, fresh air and freedom of movement. In addition, organic food is processed without additives and are not grown from genetically modified organisms (Smith-Spangler et al., 2012).

Smith-Spangler et al. (2012) demonstrated that consumption of organic food can reduce exposure to pesticide residues and antibiotic-resistant bacteria. In children under two years of age they can reduce the risk of eczema. Despite this, it was concluded that organic and conventional foods are comparable in nutrient content (Dangour, Lock, Hayter, Aikenhead, Allen & Uauy, 2010). To reduce a child's exposure to toxic pesticides, parents can be provided with a list of foods that they should try to buy organic (dirty dozen plus) and those foods that are less contaminated or it is not necessary to buy organic (clean fifteen) (Table 2.1) (Leffers et al., 2016).

Table 2.1. *Fruit and Vegetables and Pesticides*

Dirty dozen fruits and vegetables	Clean fifteen fruits and vegetables
Apple	Asparagus
Celery	Avocado
Cherry tomato	Cabbage
Cherry	Cauliflower
Cucumber	Sweet Corn
Grape	Eggplant
Nectarine	Grapefruit
Peach	Honeydew
Spinach	Kiwi
Strawberry	Mango
Sweet bell pepper	Onion
Tomato	Papaya
	Pineapple
	Sweet pea
	Sweet potato

Note. Adapted from UNICEF (2017: 36).

2.1.4.3. Breast Milk

Breast milk also possesses and can transmit chemicals to the infant. Fish consumption can cause accumulation PBCs in tissue, and breastfeeding is the main way of excreting such substances from a woman´s body (Figure 2.1). The mercury could be also presented in breast milk; the main sources of mercury in milk include diet rich in fish, amalgam fillings, and residence in mining areas (Figure 2.2). Lead and cadmium could be also found in breast milk, since they are deposited in mothers' bones during their lives and after they are releasing into body and milk as a result of bone resorptions (Pajewska-Szmyt, Sinkiewicz-Darol & Gadzała-Kopciuch, 2019).

Among children breastfed for only six months, maternal fish intakes of less than two or three times a week were associated with neurodevelopmental problems (Gascon et al., 2017). The most polluted fish species are sardine, red mullet, and mackerel, and high-fat fish (salmon and trout); but it is safe to eat fish from lower trophic levels (Pajewska-Szmyt et al., 2019). It is beneficial to limit polluted fish intake, but anyway it is noted that the benefits of breastfeeding outweigh its potential risks (Pajewska-Szmyt et al., 2019; Zayas-Mujica & Cabrera-Cárdenas, 2007); it is not necessary stopping the breastfeeding, because it counterbalance the detrimental effects of prenatal DDE/DDT exposure (Gascon et al., 2017).

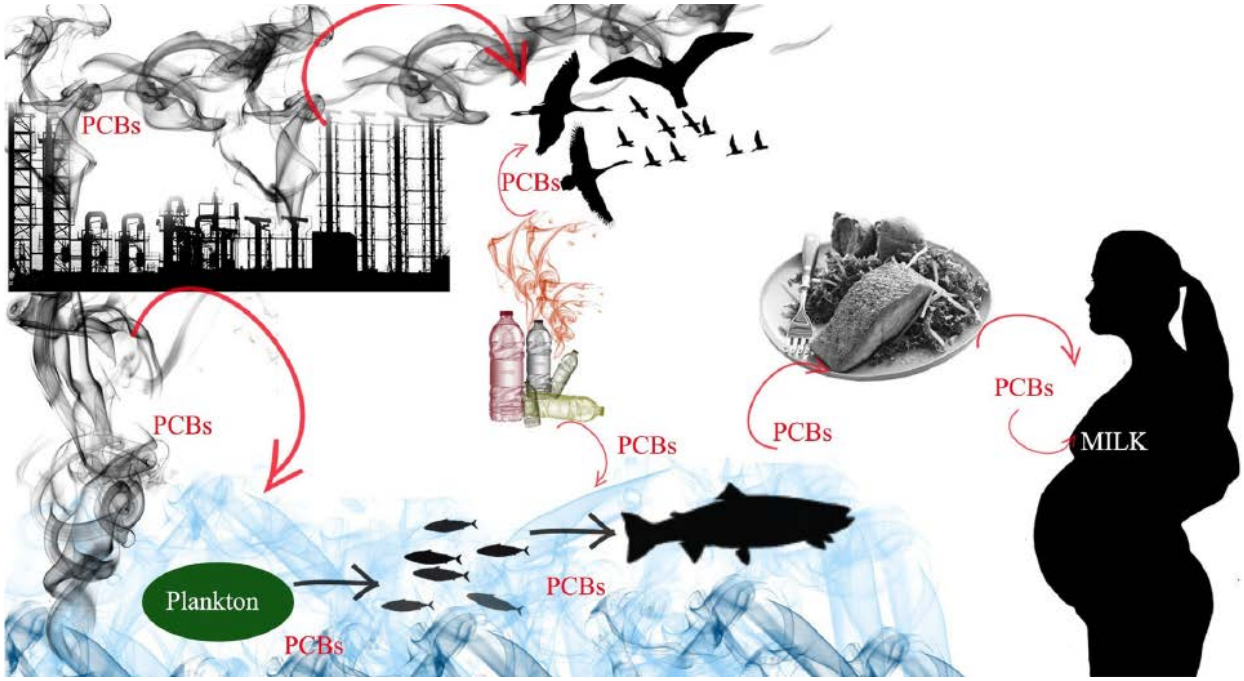

Figure 2.1. Sources of exposition and bioaccumulation of PCBs. Adapted from Pajewska-Szmyt et al. (2019:5).

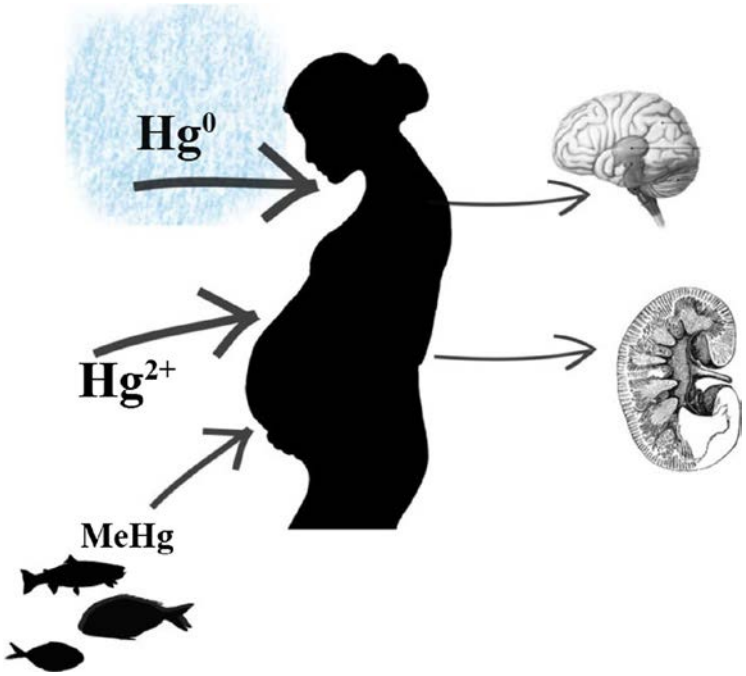

Figure 2.2. Mercury accumulation. Hg^0 = atmospheric mercury; Hg^{2+} = mercury in water; MeHg = methylmercury. Adapted from Pajewska-Szmyt et al. (2019:13).

2.1.5. Assessment of Environmental Exposures

In order to protect children from exposure to environmental risks, the relationship between environmental conditions and health outcomes needs to be better understood (Zayas-Mujica & Cabrera-Cárdenas, 2007).

In response to various calls to assess children's environmental health and to monitor progress, the global initiative on Children's Environmental Health Indicators (CEHI) was launched at the World Summit for Sustainable Development in September 2002. The MEME model, multiple exposures, multiple effects (Figure 2.3), provides the conceptual and theoretical basis for the development, collection and use of CEHI (World Health Organization [WHO], 2004).

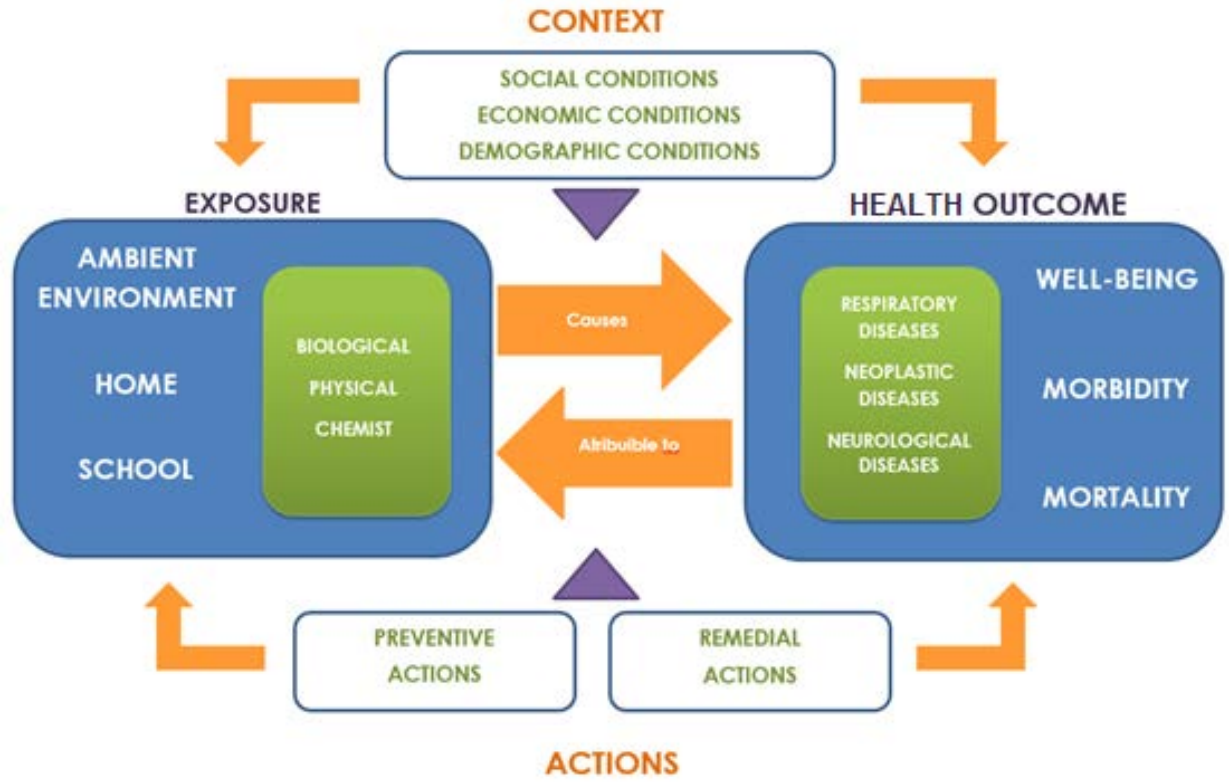

Figure 2.3. MEME model. Multiple exposures, multiple effects. Adapted from NurSusTOOLKIT Project (2018: 17).

This model highlights the importance of the complex relationships between environmental exposures and children's health outcomes. Different exposures can produce a large number of different health outcomes; similarly, specific health outcomes can be attributed to a large number of different exposures. Exposures and health outcomes, as well as the relationship between them, are affected by contextual situations, such as social, economic or demographic factors. Interventions may be aimed at reducing exposure or reducing the severity of health outcomes (WHO, 2004).

2.1.5.1. Paediatric Environmental Health Unit

The WHO considers paediatric environmental health as one of the main health challenges of the 21st century and encourages the development of strategies to address, disseminate and solve paediatric environmental health problems in units and centers of excellence. The European Union's Environment and Health Strategy identifies children as a special focus group and sets specific deadlines for the creation of multidisciplinary groups to plan and deepen aspects of paediatric environmental health. In the Community Action Plan on Environment and Health, the European Council recognizes the need to establish and implement Paediatric Environmental Health Clinical Units (PEHSUs) (Ortega-García, Ferris-i-Tortajada, Claudio-Morales & Berber-Tornero, 2005).

A PEHSU is a clinical unit located in a department or pediatric hospital where pediatricians and nurses with experience in environmental health work with other health profiles (gynecology, family medicine, toxicology, biology, environmental health) and non-health (chemistry, engineering, physic, teaching, etc.). These units are able to recognize, evaluate, treat and prevent diseases and environmental risks in childhood and provide assistance, education and clinical research (Ortega-García, 2007; Sánchez-Sauco, 2017; UNICEF, 2017).

These units were created in the United States. In Spain there is still little training in paediatric environmental health, which is one of the main barriers to the development of prevention strategies useful in daily sanitary practice. The only one PEHSU in Spain is in Murcia. Funding and support must be actively sought from the Ministry of Health and Consumption in order to increase the number of PEHSUs in the different autonomous communities, and to create environmental health committees/working groups in the national and regional nursing associations (López-Fernandez, Pastor-Torres, Sánchez-Sauco, Ferris-i-Tortajada & Ortega-García, 2009; UNICEF, 2017). In the United Kingdom, there is no record of the existence of this type of unit, so it would be necessary for the government to consider its implementation. Nowadays, much of this role is picked up by public health department, and health visitors/school nurses, along with environmental health service provided by local authority. This is the same in the most of the European countries, so European regulations should be followed to promote the creation of PEHSUs (Ortega-García et al., 2005).

The specific competencies of PEHSUs are as follows (López-Fernandez et al., 2009):

- Care skills:
  - Assessment through pediatric environmental medical records to identify children at risk.
  - Smoking and legal and illegal drugs cessation therapy aimed at parents, family and adolescents.
- Teaching skills:
  - Training to families based on the solution of specific problems in sick families and children.
  - Training health professionals to deal with the physical, chemical, biological, social and cultural interactions between children and the environment.
- Research competencies:

- Analysis, interpretation and dissemination of pediatric environmental medical records and environmental registration.

In this units have been developed two tools, the Green Leaf and the Pediatric Environmental History.

2.1.5.1.1. The Green Leaf

All visits to the pediatric nurse's office should include brief environmental histories such as parental occupation and smoking history. In primary care the nurse should have information about the community in which the child lives and the most important environmental hazards in it (Ortega-García et al., 2007, 2008).

The programs of attention to children and adolescents developed in primary care constitute a unique opportunity to detect environmental risks. Besides, they increase the environmental conscience in health professionals and families, improving the quality of life and environmental in the community. The children visits should incorporate routine questions that will help to identify the children at risk from exposures to environmental pollutants. The groups of questions or items in the Green Leaf, are grouped in reference to exhibitions coming from the community (including neighborhood and school), home, hobbies, occupational exposure and personal behaviour (Ortega-García et al., 2007, 2008).

Environmental risks that are not detected by the primary health care team are likely to go unrecorded, placing many families at unnecessary risk. Early detection of families at environmental risk allows for the treatment and/or prevention of risk factors that may have an impact on future illnesses. Regardless of the organization that is established in each team during periodical health examinations, it is necessary to incorporate environmental aspects. In addition, it contributes to the necessary health response to the growing social awareness of the relationship between health and the environment (Ortega-García et al., 2007, 2008).

The critical periods for assessing environmental hazards are shown in Table 2.2.

Table 2.2. *Assessment of Environmental Risks in the Different Periods of Childhood*

1. Prenatal
    - Neighborhood
        - Location of housing
        - Proximity to pollution sources
        - Industrial and agricultural activities close
        - Toxic landfill sites or exposures to discharges
        - Source of drinking water
        - Drainage systems
    - Home
        - Age of the housing
        - Construction materials and equipment of the housing
        - Presence of pets, pests, mold and dust in the home
        - Insulation systems, heating and cooking at home
        - Tobacco smoke
        - Use of pesticides, insecticides and disinfectants
        - Water Supply and drainage
        - Paintings and recent works in the home
        - Hobbies (crafts, gardening, engine, etc.)
        - Dietary supplements
        - Diet
        - Family atmosphere
    - Work of parents
        - Contact with dust, solvents, metals, asbestos, pesticides, hydrocarbons, etc.

2. Between 0-1 year
    - Identify the cradle, park and the area of the game within the context of safety and prevention of accidents
    - Origin of the food
    - Exposure to sunlight

3. Preschool
    - Feeding behaviour, pieces of fruit per day, consumption of organic products
    - Materials of the crafts and arts activities
    - Exposure to tobacco smoke
    - Consideration of environmental risks in the Infant School
    - Exhibitions and security in the Nursery
    - Use of chemical or toxic products in the Infant School
    - Age of the infant school, if it is located in a safe place, away from contaminated areas

4. School
    - Active and passive smoking and other drugs
    - Power
    - Community activities and outdoor
    - Sports
    - Eating habits, pieces of fruit per day, consumption of organic products or eco-friendly
    - Exposure to asbestos fibres, etc.
    - Materials of the crafts and arts activities
    - Exposure to chemicals or toxic, including lab if you have
    - If the school is located in a safe place (outside of the avenues or former channels of watercourses, etc.)
    - Distance of contaminated areas or motorways

5. Adolescence
    - Identify the job of adolescents and their knowledge about the measures of labor protection. Even in temporary jobs on weekends

Note. Adapted from NurSusTOOLKIT Project (2018: 22).

2.1.5.1.2. Pediatric Environmental History

Patients with diseases such as asthma, cancer, malformations, non-affiliated endocrine and neurological disorders, or other multifactorial pathologies, or those whose parents are concerned about some environmental hazard, need to investigate environmental antecedents more fully, through the use of the Pediatric Environmental History (PEH) (Ortega-García et al., 2007, 2008).

The PEH must be part of the standard medical record. The Pediatric Environmental History is made up of a set of basic and concise questions that allow us to detect families exposed to environmental risk factors (Ortega-García et al., 2007, 2008).

The differences between the Green Leaf and the PEH, are that the first is intended for population with detected risk factors or related environmental diseases, is intended for healthy population, its purpose is screening, does not require a specific skill for use, can be used in periodical controls, and is applied in less than 6 minutes, so its application is simple. The PEH, in contract, is intended for diagnosis or treatment of "environmental injury", it is necessary a minimum ability to use it, is usually used in the pediatric, medicine or nursing practice, is used for prevention or specific assistance and its application requires 20 to 120 minutes, so the complexity of its use is medium-high.

2.2. Nursing Training in Children´s Environmental Health

This section will describe the competencies in children's environmental health and how to achieve them.

2.2.1. Nursing Competencies in Children's Environmental Health

The environmental vision of care was established long before nursing was constituted as a profession, with Florence Nightingale in her nursing notes including the environment as the basis for restoring health and laying the foundations for the comprehensive care of the patient (physical, chemical, social and psychosocial) (Leffers et al., 2016; Sánchez-Sauco, 2017). Pediatric nurses are in a strategic and privileged place for the development of tasks related to environmental health during pregnancy, breastfeeding and the period of upbringing until adolescent (Sánchez-Sauco, 2017).

Nurses are trusted health professionals in unique positions to inform and mobilize society to act on environmental health. Nurses can promote society's response to environmental health and foster the strategies needed for a healthy future for everyone. They are the most trusted sources of information in every community. They are in hospitals, clinics, schools, workplaces, nursing homes, and people's homes. Using the REAP Model of the Alliance of Nurses for Healthy Environments (ANHE), the categories of Research, Education, Advocacy, and Practice are addressed (Anderko et al., 2016).

Nurses have contributed to the scientific literature through epidemiological studies, educational frameworks, policy statements, and practice initiatives. Nurses educate patients and other professionals, and have opportunities to include evidence and information about environmental health in colleges of nursing, in continuing education for nurses, in patient education materials, and in efforts to educate the public. Nurses are influential in policy decisions, through advocacy and by encouraging policy makers to support climate healthy decisions. It is critical that nurses educate policy makers on the need for strong action on climate change due to health impacts. Care in the setting of climate change includes understanding health impacts and treating individuals and families for health issues that arise, as well as preventing further environmental health problems through mitigation efforts. For instance, nurses are called by their professional standards to practice in "an environmentally safe and healthy manner", thus to reduce the climate impacts of their own practice (Anderko et al., 2016).

Table 2.3 shows research, practice and policy strategies that nurses can undertake to reduce the harmful health effects of climate change.

Table 2.3. *Nursing Strategies to Reduce the Harmful Effects of Climate Change*

Priority areas for	
Nursing research	Develop programs of research focused on enhancing understanding of → The health impacts of climate change → The efficacy and effectiveness of risk reduction interventions → Vulnerable populations (those with respiratory or mental health conditions, reduced mobility or cognitive function, the poor, children, those who reside or work in prone-risk areas) → Social factors that foster adaptation or alter risk → Decision support and integrated assessment tools
Nursing practice	Provide evidence-based information to help patients develop adaptive strategies focused on modifying exposure to excessive temperatures, extreme events or poor air quality → Daily monitoring of heat, air quality and pollen counts → Identification of alternative locations and types of physical activity during periods of excessive heat, pollution, or pollen counts → Identification of best times and locations (inside/outside) for exercise → Securing appropriate shelter during extreme weather events → Use of personal cooling garments and devices Support disaster preparedness and response efforts Integrate environmental health in clinical coursework (pediatrics, maternal health, geriatrics, chronic diseases, etc.)
Nursing policy	Promote public health initiatives (e.g., public transportation, improved air quality standards, mitigation programs focused on water-borne, airborne, or vector-borne illnesses) Participate in urban planning efforts to increase safe, accessible, walkable green spaces Develop relationships with local governments or planning commissions to improve the built environment Promote efforts to reduce healthcare systems' carbon footprint (e.g., waste management, green buildings, energy and purchasing, safer chemical use) Support national and international efforts to capture and store carbon dioxide (underground sequestration) and energy

Note. Adapted from George et al. (2017: 648) and Kurth (2017).

In 2009, the ANHE defined the environmental health competencies for both nurses at the basic level of education and nurses with advanced knowledge for practice (Leffers et al., 2016).

The registered nurse:

- Applies knowledge of basic environmental health concepts to nursing assessment, prevention, and control strategies.
- Incorporates environmental risk factors across the lifespan when assessing individuals, families, and/or communities.
- Utilizes scientific evidence and is guided by the precautionary principle.
- Reduces environmental health risks in the health care setting (chemical, biological, and radiological).
- Participates in creating environments that promote health and healing which include attention to sound/noise, light, and use of/access to nature.

- Collaborates with others to create and implement strategies that promote healthy environments.
- Promotes a healthy environment that respects the diverse values, beliefs, cultures and circumstances of patients, their families, and communities.
- Advocates for healthy environments that include issues associated with air, water, soil, food/agriculture, the built environment and chemicals/products.
- Promotes one's right to know about potentially harmful products, chemicals, pollutants and hazards to which people may be exposed.
- Communicates environmental health risks and exposure reduction strategies with patients, families and /or communities.
- Advocates for environmental justice, including a commitment to the health of vulnerable populations and the elimination of health disparities.

Additional Competencies for the Advanced Practice Registered Nurse:

- Evaluates outcomes related to the implementation of environmental health strategies.
- Explains the impact of social, political, and economic influences upon the environment and human health exposures.
- Analyses information on human exposure to environmental hazards and their implications for practice, such as biomonitoring and geographic information systems.
- Critically evaluates the manner in which environmental health issues are presented by the popular media.
- Supports nurses in advocating for and implementing environmental principles in nursing practice.
- Establishes partnerships that support the creation and implementation of strategies promoting healthy environments.
- Demonstrates leadership in promoting environmentally healthy, safe, and sustainable policies and conditions.

Other organizations, like the American Nurses Association (ANA) has recently released its new Scope and Standards for nursing practice that includes a standard for Environmental Health as well (Leffers et al., 2016).

Nursing's international organizations, the International Council of Nursing and Sigma Theta Tau International, recognize the importance of the United Nations Sustainable Development Goals including climate change, particularly in relationship to healthcare

workforce development and health improvement of vulnerable groups (Sullivan-Marx & McCauley, 2017). Nurses occupy a strategic and privileged place to detect families at risk. They play a very special role, as they treat childhood illnesses, educate parents and family members in health, promote awareness of health and well-being, and act as trusted professionals to advocate for and successfully support changes in health policies (Ferrís-i-Tortajada et al., 2002b; Leffers & Butterfield, 2018; McDermott-Levy et al., 2019; Nicholas & Breakey, 2017; Ortega-García et al, 2008; Veenema et al., 2017).

The problems we face at both a local and global scale make clear the necessity to improve the children´s environmental health competencies among nurses, defined as a set of related attitudes, knowledge and skills, to pioneer innovative and creative responses to achieving wider economic, social and environmental well-being (McDermott-Levy et al., 2019; Sterling, 2012). Accordingly, Álvarez-Nieto, López-Medina, Linares-Abad, Grande-Gascón and Álvarez-García (2017) defined the attitudes, knowledge and skills that nurses should have in order to provide sustainable care.

Among the most important *attitudes* are to have a vision and orientation towards the future, assuming high levels of responsibility, commitment to the environment and orientation towards change (Álvarez-Nieto et al., 2017). Nurses as advocates also have a responsibility to provide the public with evidence-based information about the health effects of these chemicals, ways to reduce exposure, and routes to advocate for changes to reduce risks to health. They can use social media in order to promote geographical and access barriers (Welch et al. 2016). Besides, they can promote a sustainable use of transport, energy-saving and the suitable placement of new schools (Sattler & Davis, 2008). Ultimately, management plans or changes in health policies could be promoted (Álvarez-Nieto et al. 2017).

The *knowledge* is required to ensure that nurses of the future are equipped to tackle these huge health challenges should include education around globalization, environmental impact, health promotion, food and the influences of production processes, the effects of smoking and environmental effects on children's health. They need to contemplate the need to know how the health of individuals, communities and populations are affected by social, political and environmental factors, and to describe the interaction of the environment and children health at different levels (Álvarez-Nieto et al., 2017). This knowledge has to be alongside the knowledge of prevention and control strategies to develop interdisciplinary interventions (Sattler & Davis 2008); for example when providing dietary or smoking cessation advice to achieve a sustainable

and efficient diet or to treat the problems derived from smoking (Álvarez-Nieto et al., 2017). In addition, there is a need for knowledge of the guiding principles of environmental sustainability and conservation, international and national legislation, all within the framework of health inequalities and the social determinants of health (Álvarez-Nieto et al., 2017).

In terms of *skills*, nurses must have the communication skills to carry out environmental health counselling and education. This also implies having skills for dialogue and influence in other groups and sectors, as well as for sensitization and citizen mobilization. They must reflect on the consequences of climate change and the possible interventions to be designed from a holistic, ethical and critical perspective (Álvarez-Nieto et al., 2017). Besides, assessment skills to detect risks in children homes, schools and communities should be developed using the Green Leaf and the Pediatric Environmental History (Sattler & Davis, 2008).

Nurses are in a unique position to promote health as this is their role. Therefore, improving the level of attitudes, knowledge and skills related to sustainability and the effects of climate change on the nursing profession will make possible a change in attitudes and modes of action in their daily work, which will result in the improvement of children's health (Richardson, Grose, Doman & Kelsey, 2014a).

It could be used the nursing process to guide advocacy for environmental health. The key elements of assessment, diagnosis, planning, implementation, and evaluation guide everything that nurses do regardless of the area in which they practice. A thorough assessment takes into account both objective and subjective data that then helps the nurse better understand the problem. First, it is important to gather as much data on a specific topic so that advocacy can be successful. Second, diagnosing the problem requires the nurse advocate to step away from the collected data, form themes, and determine the root problem. It is important during this step to remember that the data collected is evidence of a problem. Third, once the problems are identified, there are usually specific actions that need to take place. Education is always a good starting point. Fourth, in the implementation phase is necessary to be ready, do not be shy, be assertive, be professional, be persistent and collaborate with others. Finally, in the evaluation it is important that the nurse advocate take time to reflect on the advocacy that has been done and determine how to move forward (Leffers et al., 2016).

Finally, the main ten reasons why nurses and environment health go together was defined by Leffers et al. (2016):

1. Nurses provide healing and safe environments for people
2. Nurses are trusted sources of information
3. Nurses are the largest healthcare occupation
4. Nurses work with persons from a variety of cultures
5. Nurses effect decisions in their own homes, work settings, and communities
6. Nurses are good sources of information for policy makers
7. Nurses translate scientific health literature to make it understandable
8. Nurses with advanced degrees are engaged in research about the environment and health
9. Health organizations recognize nurses' roles in environmental health
10. Nursing education and standards of nursing practice require that nurses know how to reduce exposures to environmental health hazards

2.2.2. Nursing Training on Environmental Sustainability

The health impacts of climate change have already been described. These global point of crisis raise the question of how university education can best prepare its students for navigating the complexity of the modern world and its geopolitical and economic systems. With a specific focus upon healthcare, the objective became to explore practically how to embed sustainability education into the nursing curriculum more effectively (Richardson & Grose, 2015). Education must also be transformed to cope with the consequences of climate change. Developing the skills to understand the phenomenon, express one's views and act on it is critical (UNICEF, 2017).

Sterling (2012) defined Education for Sustainable Development (ESD) as: "the kinds of education, teaching and learning that appear to be required if we are concerned about ensuring social, economic and ecological well-being, now and into the future" (p.8).

The important role of ESD has been recognized by many initiatives within the framework of the Decade of Education for Sustainable Development developed by the United Nations Organization (2005-2014). In 2012, the United Nations Organization Conference on Sustainable Development Rio+20, member states decided to promote education for sustainable development and integrate it more actively into education beyond that decade. In November 2013, the global program of action on Education for Sustainable Development was discussed at the 37th session of the General Conference of the United Nations Educational, Scientific and Cultural Organization. Higher education was designed as having "a particular role to play":

> Universities must function as places of research and learning for sustainable development… Higher education should also provide leadership by practicing what they teach through sustainable purchasing, investments and facilities that are integrated with teaching and learning… Higher education should emphasize experimental, inquiry-based, problem-solving, interdisciplinary systems approaches and critical thinking. Curricula need to be developed, including content, materials and tools such as case studies and identification of best practices. (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2004, pp. 22-23)

In Andalusia, the Law on Measures to Combat Climate Change and for the Transition to a New Energy Model in Andalusia (Law 8/2018, art.25) states that the public and private universities of Andalusia will incorporate contents on the causes and effects of climate change, as well as the measures that can be adopted to mitigate and adapt to climate change, into the curricula of official undergraduate and postgraduate degrees.

Combating climate change requires specific training and adaptation actions aimed at technical and productive sectors. The Andalusian Plan of Health and Environment states that it is necessary to promote basic environmental health information and knowledge aimed at health professionals in the Andalusian public health system (primary care professionals, specialists, etc.), to help inform health professionals about the activities of environmental health services in their area, to encourage health professionals to offer accurate and evidence-based information and to contribute to the management of the perception of environmental risk in their area.

For the nursing profession, a collective response must be embraced to include climate justice, climate change, and climate stewardship as challenges for environmental and community health. These concepts, as well as health outcomes resulting from climate change, should be introduced into the curriculum at all levels of nursing education from baccalaureate through doctoral studies. Service opportunities locally, nationally, and internationally should introduce students, faculty, and practicing nurses to the challenges related to climate injustices and the various roles nurses can play in climate stewardship. Education and awareness are the essential first steps to increase nursing's role and voice in the development of health policy related to climate change (Nicholas & Breakey, 2017).

2.2.2.1. The Role of Nursing in the Face of Climate Change

Nursing education can offer a leadership role to address the mitigation, adaptation, and resilience strategies for climate change. The Ecological Planetary Health Model (Figure 2.4) offers a framework for nursing to integrate relevant climate change education into nursing curricula and professional nursing education (Leffers, Levy, Nicholas & Sweeney, 2017). Individual nurses can make their practice more sustainable by avoiding unnecessary use of materials, encouraging the use of public transport, using recycled or sustainable materials and promoting policy changes. Nurses who work with children families can educate them to reduce exposures to products that contain toxic chemicals. Applying the nursing process at the community-level is necessary to improve health, since exposures to pollutants in the water, air, soil and food supply are beyond the control of any one individual (Leffers et al., 2016).

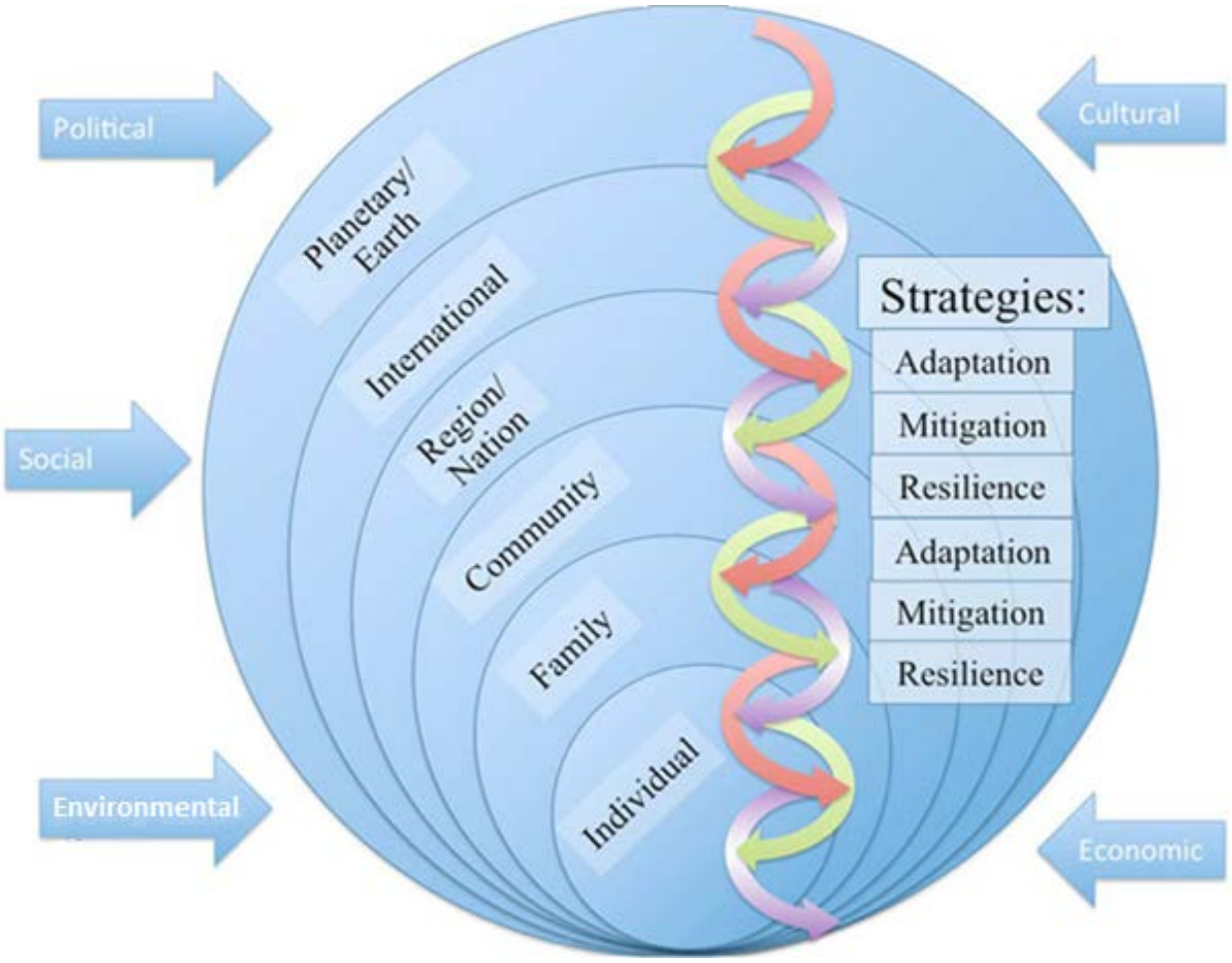

Figure 2.4. Ecological planetary health model. It is illustrated by concentric circles, highlights the interrelationship and multiple levels of influence that nurses have on behaviours and actions to address the health of our planet. Each climate strategy is depicted as a colored cord on an integrated trajectory demonstrating that each climate strategy occurs in concert with the other, and the climate strategies influence the interventions between all levels of the model. The arrows outside the circles represent the political, social, cultural, economic, and environmental influences on human health and the health of the planet. Adapted from Leffers et al. (2017: 683).

Nurses who are educated in climate health can play an important role in recognizing the areas to mitigate climate impacts, support climate adaptation, and work across disciplines to promote resilient populations and communities. There are three actions or interventions that nurses can take to address climate change and health: Mitigation, adaptation and resilience. These interventions mirror the levels of disease prevention that are familiar to nurse educators: Primary, secondary, and tertiary prevention (McDermott et al., 2019):

1. Primary prevention relies on methods to promote health and prevent disease; whereas mitigation efforts related to climate change are methods to prevent or reduce GHG emissions (the health sector produces approximately 5% of total carbon dioxide emissions in the European Union (KPMG, 2012)), such as reliance on energy-efficient methods to transporting nursing staff to the hospital and diligence in the use of supplies, especially petroleum-based products.
2. Secondary prevention is related to screening for and treatment of illnesses; climate adaptation is the assessment, planning, and management of climate health impacts.
3. Tertiary prevention is related to managing the residual effects of an illness or health condition; whereas climate resilience is an interdisciplinary approach to establishing communities and health systems that not only can withstand the impacts of climate change but also can thrive during periods of climate stress or disasters. Climate resilience is achieved when economic, social, communications, and political systems are responsive to climate impacts.

2.2.2.2. Involvement of Nursing Organisations in Sustainable Training

There is a growing demand from different sectors to include sustainability and climate change issues in the nursing curricula (Goodman & Richardson, 2010; Lilienfeld, Nicholas, Breakey & Corless, 2018; Middleton et al., 2014; Sterling, Maiteny, Irving & Salter, 2005). Internationally, the G8 University Summit (2008) help in Japan issued the *Sapporo sustainability declaration*, which states:

> Universities have a critical role to play in educating future generations, disseminating information about sustainability, and particularly by training leaders with the skills to solve regional and local problems from a global and interdisciplinary perspective.

Nursing organizations (ANA, National League for Nursing, ANHE, International Council of Nurses, Quad Council of Public Health Nursing Organizations, National Student Nurses

Association, and American Academy of Nursing, as well as Global Consortium on Climate and Health Education) are developing climate change guidelines and principles especially focused on teaching health professionals about climate change, vulnerability, and prevention of illness due to exposures to extreme weather events including heat, air pollution, and exposure to solar radiation (Leffers et al., 2016; McDermott-Levy et al., 2019; Sullivan-Marx & McCauley, 2017).

Specifically, the ANHE has the mission of promoting healthy people and healthy environments by educating and leading the nursing profession, advancing research, incorporating evidence-based practice, and influencing policy. Its main aims are (Leffers, et al., 2016):

- Environmental health content be included into all levels of nursing education as well as for professional development.
- Environmental health content be included in nursing degree and certification examinations.
- Education environmental health should be interdisciplinary.
- Environmental health content be part of life-long learning and continuing education for nurses in practice.
- Resources and educational opportunities should be available through public and private organizations and agencies.

2.2.2.3. Involvement of Universities in Sustainable Training

University courses/curriculum is the best option to prepare nursing students to effectively address health impacts of climate change because the information received through mass communication is not sufficient to prepare future nurses to effectively design interventions to tackle health effects of climate change (Nigatu, Asamoah & Kloss, 2014). Nurses have a duty and obligation to promote environmental health measures as one of our highest current priorities, to ensure a sustainable and healthy environment for present and future generations (Ortega-García et al., 2008). Nevertheless, nursing students need a more comprehensive curriculum on climate change and its impacts on health (Nigatu et al., 2014). In addition, preparing nursing students to address climate change can promote health protective behaviours such as walking and biking, developing research related to climate adaptation, and supporting climate resilient health systems (McDermott-Levy et al., 2019). Nurses must be able to manage environmental problems in children and provide environmentally friendly care.

Nurses have a responsibility to engage in initiatives to reduce environmental degradation and improve the overall quality of life. These responsibilities derive from knowledge of the current and potential effects of environmental degradation on children's health. Although health professionals have little legal capacity to control sources of environmental risk, they have all the scientific authority to defend their reduction and elimination (Ortega-García et al., 2008). Nurses must be fully trained in children's environmental health, since during the different stages of children's growth and development, they can prevent or take care of different environmental problems. Children are a sector at greater risk from environmental aggressions, which cause physical, mental and social disturbances.

There is little or no training in environmental health for most nurses that places many children at risk. In recent years there has been growing popular concern about the effects on human health caused by unstoppable environmental pollution. This contrasts with the scarce medical attention devoted to environmental health in undergraduate and postgraduate academic training. Specifically, information regarding the repercussions of environmental aggressions in the fetal, infantile and juvenile periods is widely scattered in selective scientific journals that are not usually read by most clinical nurses (Ortega-García et al., 2008).

As Anaker and Elf (2014) said, environmental awareness in nursing is very important and it is necessary to increase awareness of environmental issues (López-Fernández et al., 2009). Table 2.4 shows recommendations to ensure that nurses, globally and across all educational settings, will engage in and develop regional, culturally appropriate, and professionally relevant competencies, curricula, and educational strategies to advance nursing education in addressing climate change and children health (Leffers et al., 2017).

From the academic point of view, the inclusion of competencies and topics on environmental sustainability is fundamental in the nursing curricula. In that way the social responsibility and the idea of preserving the planet would be present in nursing training. What must be achieved is solid knowledge and critical reflection, taking into account the acquisition of cognitive, affective and behavioural skills (Barna, Goodman & Mortiner, 2012; Goodman, 2011; Goodman & Richardson et al., 2010; Lopes-Monteiro-Dantas-da-Silva, Suzelaine, Picinini-Santos, & Ligia-de-Oliveira, 2010).

Table 2.4. *Climate Change Recommendations for Nursing Education*

1. Employ an ecological perspective built from the Ecological Planetary Health Model for nursing to ensure the interactive nature of human actions upon global impacts as well as global effects upon individual human impacts.
2. Integrate climate change impacts and responses into pre-professional nursing education, graduate level nursing education, and professional development programs for nurses in practice.
3. Include both lifespan and social determinants of health approaches to identify individuals and populations most vulnerable to climate impacts.
4. Content for the care of children should be specific to the particular vulnerability of children to climate disasters, food and water insecurity, air pollution, vector-borne diseases, diarrheal diseases, and malnutrition.
5. Include climate vulnerability related to the care of pregnant women and children. In particular, pregnant women are more vulnerable to excess heat events and inhalation of particulate matter that can result in adverse birth outcomes.
6. Integrate into the care content that addresses the increased vulnerability of various occupational groups and people living with disabilities. Additionally, the impacts of climate change upon those with pre-existing chronic conditions must be considered.
7. Consider the social factors that contribute to vulnerability for adverse health outcomes from the impact of climate change. Social determinants such as income, education, transportation, neighborhood, housing, language proficiency, social isolation, marginalization, and other social stressors impact health outcomes must be considered.
8. Include content regarding the policy and advocacy role of nurses to address health hazards in the environment and to develop policy to reduce climate change health risks through mitigation, adaptation, and resilience.
9. Integrate the climate change strategies of mitigation, adaptation, and resilience into all content areas for education and practice. This includes efforts to take personal and professional action for mitigation, to prepare for disaster and emergency response, and to work for climate justice to build resilience globally.

Note. Adapted from Leffers et al. (2017: 684).

2.2.2.4. Barriers to the Inclusion of Sustainable Education in University Training

Universities play a leading role in developing forms of education to solve problems associated with sustainable development (Álvarez-Nieto et al., 2017). However, according to Kirk (2002), nursing students are being poorly equipped to make any connections between climate change, sustainability and health. Unfortunately, the health threats inherent in climate risk exposures are poorly understood by many nurses, who often see climate change actions as incongruent with their daily work (George et al., 2017). The wider topic of environmental responsibility should be included in nursing and medical curriculums to help health care professionals to understand the connection between their practices, resource scarcity and climate change (Kallio, Pietilä, Johson & Kangasniemi, 2018). The main barriers to changing the nurse education curriculum can be summarized as follows (Goodman & Richardson, 2010):

- Instrumental/vocational training orientation to meet local, regional and national needs.
- Approaches to health and illness are individualistic and biomedical.

- There is a lack of specific leadership on climate change and sustainability in both professional nursing and nursing in higher education.

Specifically the barriers and possible pathways are shown in the Table 2.5:

Table 2.5. *Barriers and Possible Pathways to Embedding ESD*

Barrier	Possible pathway
Crowded curriculum	ESD does not mean adding significant new content: Often it is a matter of modification of existing content.
Perceived irrelevance	Whereas is more "obviously relevant" to some subjects than others, virtually all can both relate and benefit in some way.
Limited staff awareness or expertise	Professional development, linking up with experienced colleagues and plugging into ESD networks can help.
Limited institutional commitment	Work longer term to build alliances, interest and commitment. Develop a business case for ESD.
Limited commitment from external stakeholders	Check local and regional policies for sustainability objectives, research on employers´ views, and check professional bodies regarding policy intentions.
Lack of incentives	Create your own where necessary.
"Silo" organisation	Start making horizontal links, cross-school, cross-faculty and cross-institutional.
Too demanding	Learn from others in your institution or beyond who have made a step towards sustainability, see what benefits have ensued and start small yourself.
Lack of resources	See what existing resources can be reoriented.

Note. Adapted from Sterling (2012: 27-28).

Another issue is the need for teacher training in environmental matters, because without them it is impossible an adequate training (Álvarez-Nieto et al., 2017; Jones, Selby & Sterling, 2010). Azcárate, Navarrete and García (2012) and Ull, Axnar-Minguet, Martínez-Agut, Palacios and Piñero (2010) say that Spanish university teachers have a lack of environmental knowledge and that most have not yet joined the process of sustaining their own teaching practice. Some barriers for them to including ESD in nursing curricula are, time, concern about lack of knowledge, and reluctance and prejudice from students (Jones et al., 2010)

These barriers must be overcome, since environmental teaching and learning must be present in undergraduate and postgraduate university education through the inclusion of specific competencies in environmental sustainability curricula, from a theoretical and empirical point of view that frames the overall practice of nursing professionals. Competence in nursing practice follows from knowledge and skill acquisition gained from integration of climate change content into nursing education (Butterfield et al, 2014; Campbell, 2008; Corrêa, Lunardi & Do-Conto, 2007; Goodman, 2013; Goodman & East, 2014; Grande-Gasón, Álvarez-Nieto, Linares-Abad, López-Medina, Parra-Anguita & Álvarez-García, 2016; Leffers et al., 2017; López-Fernández et al., 2009; Richardson et al., 2014a; Sayre, Rhazi, Carpenter & Hughes, 2010).

2.2.2.5. Pathways for the Inclusion of Sustainable Education in University Training

In undergraduate curricula, environmental learning should be developed from theoretical and practical modules. The classes should be with small groups, with an average of 20 students, self-directed activities, own study time and expository theoretical classes with support materials (Lopes-Monteiro-Dantas-da-Silva et al., 2010). Jones et al. (2010) said about sustainable education: "This reflects a move away from the conception of ESD as embedding prescribed, pre-defined content into curricula towards an understanding of sustainability as a different way of thinking and of teaching" (p.40). It is clear that many of the core principles of integrating sustainability into Higher Education require substantial shifts in thinking and practice that may be out of reach of the individual lecturer (Table 2.6). We can use the "4 Rs model" to assess, evaluate and discuss possible changes with appropriate colleagues; it is simple, regarding what we do now: Retain, Revise, Reject and Renew.

Table 2.6. *Integration of Sustainability in Higher Education*

Integration of sustainability within higher education implies shifts	
From	To
Transmissive learning	Learning through discovery
Teacher-centred approach	Learner-centred approach
Individual learning	Collaborative learning
Learning dominated by theory	Praxis-oriented learning linking theory and experience
Focus on accumulating knowledge and a content orientation	Focus on self-regulative learning and a real issues orientation
Emphasis on cognitive objectives only	Cognitive, affective and skills-related objectives
Institutional, staff-based teaching/learning	Learning with staff but also with and from outsiders
Low-level cognitive learning	Higher-level cognitive learning

Note. Adapted from Jones et al. (2010: 42).

There are different models to engage the students with concepts of sustainability during their university courses. Briefly, these can be described as the "infusion" model (sustainability issues are woven into existing curriculum), the "generic" model (a generally available framework module is customized by individual disciplines) and the "common" model (a common cross-disciplinary sustainability module is available as an option for all students) (Jones et al., 2010). The generic and common models would pose difficulties for nurse education given the issues of curriculum space and funding. Thus the infusion model seems most appropriate according to some authors (George et al., 2017; Goodman and Richardson, 2010; McDermott-Levy et al., 2019), since the content could be integrated across science and clinical course work. Potential

ideas about how to integrate climate change across the nursing curriculum are showed in Table 2.7.

Table 2.7. *Recommendations by Course to Integrate Climate Change across the Nursing Curriculum*

Course	Mitigation	Adaptation	Resilience
Foundations in nursing	Track the lifecycle of supplies, equipment and cost. Examine one's own personal carbon footprint using an on-line calculator. Examine the role of the nurse in healthcare sustainability or Green Team.	Read emergency plans for healthcare facilities. Participate in mock disaster events on campus or in the community.	Observe or read minutes of a healthcare organization's facilities planning meeting and identify areas for resilience.
Health assessment	Include climate risk in health assessment (outdoor activity: Work, recreation, home location). Target specific vulnerabilities (age, nutritional needs, and risk of dehydration, excessive heat, poor air quality and adverse weather events).	Based on assessment findings, evaluate climate adaptation (cooling centers, evacuation plan, and alternative energy support for electric powered devices).	Based on assessment findings, establish a nursing care plan to reduce climate risk. Establish a personal plan for disaster preparedness.
Nutrition	Identify agricultural practices and sources of food waste that contribute to climate change. Evaluate the distance that the student's food travels (food miles). Participate in a campus garden project.	Establish a plan for a population that is experiencing altered nutrition of food or access to safe water.	Develop a plan for food insecurity related to crop loss. Examine policies that ensure food access to populations.
Maternal infant health	Judicious use of energy and supplies in school of nursing and clinical setting. Discuss/evaluate transportation to clinical site.	Teach women to monitor, interpret, and modify activity based on excess heat and air quality readings. Develop an emergency plan for climate related disasters.	Instruct parents how to assess water availability and quality. Advise prospective parents to prepare for climate events during pregnancy and for care of the newborn.
Child health	Judicious use of energy and supplies in school of nursing and clinical setting. Discuss/evaluate transportation to clinical site.	Develop a plan for children's exercise during a heat wave or poor air quality. Develop a plan for food and water security for children during climate events.	Identify local sites for cooling and food and water resources.
Adult and gerontology health	Judicious use of energy and supplies in school of nursing and clinical setting. Teach the relationship between air quality, water quality, and stress to chronic illness in adults. Discuss/evaluate transportation to clinical site.	Patient teaching related to cardiac, respiratory, renal diseases regarding extreme heat, poor air quality, and limited water. Develop a plan for an elderly client living in an urban heat island.	Develop a plan to meet the nutritional needs for patients with limited mobility/confined to home. Examine local policies to address emergency needs of elderly and people with disabilities.

Note. Adapted from McDermott et al. (2019).

Table 2.7 Continuation. *Recommendations by Course to Integrate Climate Change across the Nursing Curriculum*

Course	Mitigation	Adaptation	Resilience
Mental health	Examine the evidence of time spent outdoor in natural settings and mental health. Identify specific risks to mental health for populations. Discuss/evaluate transportation to clinical site.	Address client needs for medications during extreme heat, such as Lithium Carbonate. Locate or develop educational materials for community leaders related to post traumatic stress for those impacted by severe weather events.	Ensure medication supply during weather events.
Community health	Conduct a windshield survey to identify community strengths to reduce GHG emissions. Integrate the concept of planetary health into course content. Apply knowledge about climate impacts using the Ecological Model for Planetary Health. Explore governmental strategies to reduce risks from climate related vector borne illness.	Participate in a disaster drill related to a natural disaster. Develop climate education information materials to help prepare communities for climate events.	Explore factors to ensure continuum of care during extreme weather events. Develop an emergency preparedness plan with community partners. With local community members identify, strategies for community resilience. Create a model for Climate Resilient City (working across disciplines).
Nursing leadership	Evaluate energy use in healthcare and opportunities to reduce energy use. Examine nursing organization's position statements about climate change.	Identify carbon footprint of a healthcare organization.	Examine or participate in a health facility or community climate resilience plan.
Evidence based practice/research	Examine the evidence that supports mitigation strategies. Develop research questions related to effective mitigation practices.	Examine the evidence that supports adaptation strategies. Develop research questions related to health impacts of adaptation strategies.	Examine the evidence that supports climate resilience. Develop research questions related to working across disciplines to address climate resilience.

Note. Adapted from McDermott et al. (2019).

We have to remember that ESD "should emphasize creative thinking, innovation and the long-term perspective, particularly our responsibility towards future generations" (Sterling, 2012, p.36). Potential learning approaches are participative inquiry/action research, where students investigate an issue which is of importance to them personally; transformative sustainability learning, where tutors attempt to use the three domains of learning, cognitive, psychomotor and affective, to engage students in a transformative educational experience; and action competence, where students are encouraged to envisage alternatives and solutions to unsustainable practices. Specific teaching strategies advocated for environmental education include those listed below (Barna et al., 2012; Cotton & Winter, 2010; Galiana-Sánchez & Gascón-Pérez, 2004; Jones et al., 2010; Longhurst, 2014; Sterling, 2012; Sterling et al., 2005;):

- Role-plays and simulations. They provide an opportunity for students to gain an in-depth understanding of another person´s perspective and to empathize with others.
- Group discussions. The use of a discussion may be an attempt to counter-act the risk of the tutor taking a transmissive or authoritarian approach, thereby enabling students to discuss their own and others´ views.
- Stimulus activities. A stimulus activity might involve watching a video or looking at photos, poems or newspaper extracts to initiate reflection or discussion. Students may even be involved in producing their own work such as taking photos around the campus to stimulate a discussion on campus greening. Use of videos or externally-produced documents potentially enables the tutor to bring in a wide range of viewpoints for critical analysis, and this approach is feasible even with very large groups.
- Debates. Debates in which two groups of students put forward opposing arguments on an issue are often recommended as a method of teaching about sustainability since they encourage students to gather information about the topic and develop an argument.
- Critical incidents. Students are given an example and asked what they would do, what they could do and what they should do. This allows them to consider their personal perspectives and actions in the lights of a moral or ethical stance. The approach can also be used with groups to promote awareness about multiple perspectives on sustainability.
- Case studies. Tutors use case studies to bring ESD into areas of the curriculum that had not traditionally involved a clear focus on sustainability, and to provide students with a holistic view of an issue. Case studies enable students to investigate issues that affect their local area, to work with private enterprises and community groups and to work together in finding solutions to local issues.
- Reflexive accounts. Considering their own position in relation to new knowledge about sustainability can help students understand how individual actions contribute to sustainability.
- Personal development planning. It is a structured and supported process undertaken by a learner to reflect upon their own learning, performance and/or achievement and to plan for their personal, educational and career development.
- Critical reading and writing. Reading and writing are often downplayed in favour of more interactive pedagogies. However, these are important social practices and the key to progressing sustainability and literacy.

- Problem-based learning. In the context of ESD, a sustainability-related issue may be identified and students asked to research this to generate a body of knowledge. So, they can develop a vision of alternative actions and potential solutions to the problem, which they use to devise a plan of action. The action may then be carried out, followed by a period of reflection and evaluation. This process can be extremely useful because it promotes both the conceptual and practical aspects of sustainability literacy.
- Fieldwork. It is an example of experimental pedagogy that can influence students´ emotions and help develop the critical thinking skills so essential to understanding the complexity of sustainability. Fieldwork for sustainability can be based on issues in the local community and environs, linking theory to real-world examples. There is also evidence that outdoor experience is an important precursor to understanding sustainability.
- Modelling good practice. The importance of learning taking place implicitly through the hidden curriculum and outside the classroom should not be underestimated, because it is necessary to go well beyond turning off lights and providing recycling facilities. A personal level there is a huge amount we can do, since in the position where you have a teacher and students, you set an example, it is not just what you say, it is what you are. If a teacher says to students that they should be going by public transport, he or she should not go out to his or her car and drive home every evening.

These techniques show that nurse educators must utilize a variety of teaching strategies to get improve attitudes, knowledge and skills related to children´s environmental health, promote an in-depth understanding of information, and encourage students to compare new knowledge with existing knowledge, generating a relationship between the two (Breytenbach, Ham-Baloyi & Jordan, 2017).

2.2.2.6. Sustainability in Higher Education across Europe

Opportunities and hopes for including sustainability in higher education across Europe are anticipated with the consolidation of the Bologna Process, as this leads to a major overhaul of what tend to be rather rigid and historically grounded structures by creating a European Higher Education Area.

In *Spain*, the biggest handicap to progress in ESD is the common and residual resistance to change at higher education institutions and a high degree of inconsistency in decision-making processes in curriculum design and innovation (Jonet et al., 2010). The Spanish legislation (Royal

Ordinance, 1393/2007, of 29 October, establishing the organization of official university teaching) for the process of improving higher education, determine the including in the nursing curricula a series of key competences for sustainability (Álvarez-Nieto et al., 2017). For example, the experience of mainstreaming environmental goals in the Technical University of Catalonia´s overall strategic planning has increased the level of "greening" but has not incorporated sustainable development in the redesign of specific curriculum programmes (Jonet et al., 2010). At the University of Jaén, children's health and environmental issues have been integrated into nursing training since 2016, and the Catholic University of Murcia has integrated sustainability issues throughout the nursing curriculum since the 2018/2019 academic year. Specifically, in Andalusia, in October 2018 was presented a Law on Measures to Combat Climate Change and for the Transition to a New Energy Model in Andalusia (Law 8/2018, art. 5), which supports the need to incorporate into undergraduate and postgraduate university curricula content on the causes and effects of climate change, as well as measures that can be taken to mitigate and adapt to climate change.

In the *United Kingdom*, the nursing faculties have also not explicitly drive climate change and sustainability into nursing curricula and do not state that nurses need attitudes, knowledge and skills to address environmental issues as part of nursing practice. Only a few individual universities, University of Bradford and Plymouth, have decided to take some steps toward change, without government support. In contrast, the National Health System (NHS) continues to exacerbate climate change, with recent estimates suggesting that it is responsible for 5% of the road transport emissions in the United Kingdom and that in total it emits around one million tonnes of carbon each year, and nurses do not know how to manage environmental health problems (Goodman & Richardson, 2010).

In *Germany*, an interesting phenomenon is the emergence of *Gestaltungskompetenz* as a concept to help articulate the qualities, competencies and attributes learners need to develop when engaging with sustainability issues. It is sometimes described as the forward-looking ability to modify and model the future of the societies in which you live, participating actively in the spirit of sustainable development (Jones et al, 2010; Sterling, 2012). Some hospitals have voluntarily hired environmental managers to oversee the strategic development of environmental policies and ensure that they are sustainable from an operational point of view (Kallio et al., 2018).

In the *Netherlands*, the Dutch Foundation for Sustainable Development in Higher Education (DHO) was established in 1998 and within 20 years was exerting significant influence on almost every higher education institution in the country. The DHO aims to develop learning opportunities, innovative learning environments and methodologies in higher education that enable individuals to develop competence in sustainable development. In this country has been developed the Auditing Instrument for Sustainability in Higher Education (AISHE), it is a list of substantial targets will be produced to refocus the curriculum towards sustainable development (Jones et al., 2010):

1. A faculty or study board, dean or coordinator decides to audit a study programme.
2. At least one coordinator or study manager, ten teachers and three students are committed to attend the full audit.
3. A full audit takes meeting of half a day, two separate days or one full day.
4. During the first meeting, the AISHE consultants explain the audit and afterwards all participants fill in a list of 20 criteria.
5. During the second “consensus” meeting, all personal scores are discussed.
6. The first step of the second meeting is to reach consensus on the present situation with respect to sustainable development, the second step is to explore the desired situation and formulate actions for improvement.
7. At the end of the meeting, three to five items are selected as priorities.
8. All results of the meeting are entered directly into the AISHE software tool and the results are accessible through clear, comprehensible diagrams.
9. Universities may receive the Certificate for Sustainability in Higher Education.

In *Sweden*, a 2006 amendment to the Higher Education Act charged universities to promote sustainable development in all their activities. This legislative amendment greatly aided the formation and development of the Regional Centre of Expertise on ESD in Sweden showing the importance of government in furthering sustainability in higher education. More generally, the concept of Sustainable Development has generally focused on ecological sustainability, but it is slowly being widened to encompass social, economic and cultural dimensions. Centres promoting education, research and cooperation both within a university and alongside local, regional, national and international actors have been established at several universities, although most institutions report that they are still in the initial stages of integrating sustainability into their curricula (Jones et al., 2010).

In *Belgium*, sustainability is not a structural part of the curriculum. But, heavy emphasis is placed on environmental management. The *EcoCampus initiative* set up by the Flemish Government encourages, rewards and assists higher education institutions in moving towards environmental sustainability and sound operational and management practices (Jones et al., 2010).

In the *Russian Federation*, there has been a general shift away from general environmental education to ESD. Geography has played a leading role, not least because it can act as a bridge between the natural and human sciences and because there is an academic heritage of nature management derived from the work of the Soviet scientists. The Moscow State University is taking a leading in advancing in sustainable higher education (Jonet et al., 2010).

2.2.2.7. Include Sustainability within University Campuses

It would be good to include extra-curricular activities that enable students to develop attitudes, knowledge and skills to contribute to sustainable development. In most cases, "campus greening" should be made at the same time as curricular changes. Examples of this has been showed in the University of Bradford and Plymouth where it is promoted the sustainability in the campus at the same time as curricular changes is being implemented. Besides the University of Plymouth has a Centre for Sustainable Futures that developed the "4C" model in which Curriculum, Campus, Community and (institutional) Culture are seen as mutually enfolded and complementary foci of the sustainability university (Figure 2.5) (Jones, Selby & Sterling, 2010).

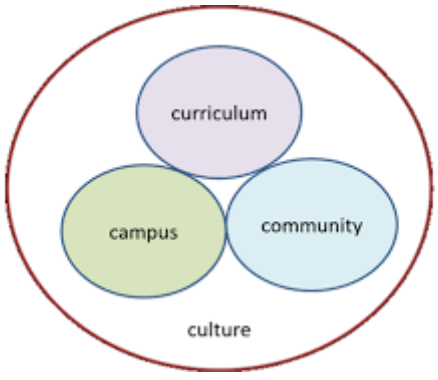

Figure 2.5. The "4C" model. Adapted from Jones et al. (2010: 7).

The universities have to be a sector leader in re-thinking and re-orienting its policy and practice towards sustainability, recognizing that our graduates face a rapidly changing world characterized by complexity and uncertainty, risk and opportunity. They have to develop a strategy and activities that could transform the university towards a state where sustainability

permeated the curricula, physical campus, and the whole institutional culture, as well as influencing relations with immediate environs, and the wider region, and contributing to similar work taking place in the sector (Warwick, 2015).

Following the Green Metric, a world university ranking who assess setting and infrastructure, energy and climate change, waste, water, transportation, and education and research, the most sustainable university in the world is Wageningen University & Research (Netherland). Among the top 100 are 10 British (University of Nottingham, University of Oxford, Nottingham Trent University, Keele University, University of Bradford, University of Sussex, University of Warwick, University of Leicester, University of Lincoln and Glasgow Caledonian University) and 6 Spanish (University of Alcala, Autonomous University of Barcelona, Autonomous University of Madrid, University of Oviedo, King Juan Carlos University, Technical University of Valencia and University of A Coruna) universities.

The University of Jaén is the 201 in this ranking since it has a green center which is focused in getting a green campus and some degrees has started to include sustainable contents in their curriculum following the EcoCampus initiative. Other Spanish universities interesting in getting sustainable competences among nursing students are University of Granada, University of Málaga, University of Almería, University of Córdoba, University of Sevilla, University of Lleida and University of Cantabria.

The University of Plymouth has developed the slogan “Sustainability with Plymouth University”, since it is trying to get a green campus, with multiple recycling option, workshops and conferences about this topic, rebuilt areas to make them sustainable and embedding environmental sustainability in the curriculum of different degrees. Child health nursing lecturers are specially compromise with capacity child health nursing students with the needed children´s environmental health attitudes, knowledge and skills. The Green Gown Awards recognized the exceptional sustainability initiatives undertaken by this university in 2016.

2.2.3. Use of New Technologies in Education for Sustainable Development

Due to the hands-on approach of the nursing profession, the delivery of undergraduate nursing education has remained predominately face-to-face with a component of time spent in clinical settings (Ota, Peck & Porter, 2018). But, as well as the challenge of preparing suitably competent graduates for clinical practice, nursing education providers must integrate e-learning into curricula, particularly in view of preparation for the “digital age” of health care, to move

away from “instructor-centered, learner-passive” teaching to “student-centered, integrative learning” activities (McDonald & Boulton, 2018). E-learning has recently become an increasingly used format for the education of health professionals (Góes, Fonseca, Furtado, Leite & Scochi, 2011; Lahti, Kontio, Pitkänen & Välimäki, 2014b; Ota et al., 2018). E-learning is a widely accepted term to describe educational material that utilizes Information and Communications Technology (ICT) for learning purposes (McDonald & Boulton, 2018). It is considered a good methodological strategy for training in children´s environmental health, as it offers an alternative method of education (Lahti, Hätönen & Välimäki, 2014a; Voutilainen, Saaranen & Sormunen, 2017).

This type of learning, in addition to increasing the student's knowledge and achieving a transfer of this to the daily practice, produces positive feelings, personal and professional growth, as well as satisfaction (Breytenbach et al., 2017; Hoffman et al., 2011; Lahti et al., 2014a, 2014b). The development of cognitive skills such as clinical reasoning and decision making has also been observed (Hoffman et al., 2011). Some studies even claim that e-learning helps to acquire knowledge faster than traditional instructor-led methods (Lahti et al., 2014b; Voutilainen et al., 2017); specifically a meta-analysis conducted by Voutilainen et al. (2017) found that e-learning methods resulted in test scores that were 5.24 points higher than a conventional method on a 0-100 scale, but clinical thinking was the only subject that was significantly better improving with conventional learning such as Case-based learning (CBL) (McDonald & Boulton, 2018; Voutilainen et al., 2017).

CBL is an effective educational method for improving the learning and clinical reasoning and problem-solving skills of students. Case scenarios are used to stimulate students’ learning interest, classroom discussion, and collaborative analysis. The key feature of CBL is that it involves small-group interaction, student-centered exploration of realistic, specific clinical cases and scenarios, and students’ collaborative efforts to generate possible solutions to resolve clinical issues, problems, and questions. Developments in e-learning technology have supported the development of the Web-based CBL approach to teaching as an alternative to the traditional class-room approach. New e-learning technology allow that this could be organized in an online platform where the study case is uploaded and after the tutor address these questions in a face-to-face class (Chan, Chair, Sit, Wong, Lee & Fung, 2016).

Some of the characteristics that e-learning possesses are that it can produce a separation between tutor and student in time and space, so that learning takes place according to the convenience of the students, without the need to worry about transport (Chan et al., 2016; Du

et al., 2013; Góes et al., 2011; Lahti et al., 2014a; McDonald & Boulton, 2018; Ota et al., 2018; Pfefferle, Van-den-Stock & Nauerth, 2010). It is possible study from mobile phone, and this is a very value characteristic for students (McDonald & Boulton, 2018). It is possible to create a web with information about the course, an index or an outline of the same; diverse materials, from slides to brochures or articles, audios or videos that facilitate the interest and understanding of complex knowledge; communication can be produced through e-mail, discussion forums, video conferences, or e-conferences such as through the GoToMeeting and GoToWebinar conferencing facilities, or even Facebook groups that allow a remote desktop connection to present a conference with screen sharing (Breytenbach et al., 2017; Pfefferle et al., 2010; Warwick, 2015), as well as reading existing posts and giving and receiving feedback to and from their peers (McDonald & Boulton, 2018); in addition, through the platform it is possible to carry out evaluations, which allow the management of statistics; finally, it is also possible to include links to useful internal and external resources (Du et al., 2013; Lahti et al., 2014a).

But all are not advantages, since negative experiences have been observed, such as feelings of isolation and lack of support from peers, due to the loss of the social component of learning (Lahti et al., 2014b; McDonald & Boulton, 2018); in addition to the need for skills for access to these web materials or the possible occurrence of hardware or software problems (Du et al., 2013; Góes et al., 2011; Hoffman et al., 2011; McDonald & Boulton, 2018; Ota et al., 2018; Voutilainen et al., 2017). There is also danger in importing e-learning materials to undergraduate curriculum, where content is too advanced for early undergraduate level (Breytenbach et al., 2017; McDonald & Boulton, 2018). Online modules about sustainability can be used as an aid by lectures with little experience of sustainable development (Jones et al., 2010) but teachers also need a great deal of time to develop these materials (Du et al. 2013). Nurse educators should be trained to understand the strategies' benefits and their potential impact on knowledge acquisition, critical thinking, decision-making, and competencies that are essential for today's nursing student (Breytenbach et al., 2017).

Recent studies showed no significant difference between the face-to-face and e-based learning approaches in terms of self-learning ability, clinical thinking and problem-solving ability, nursing assessment skills and knowledge, and satisfaction with the approach (Chan et al., 2016; McDonald & Boulton, 2018). To overpass the difficulties presented by pure e-learning, blended learning has emerged. It is defined as the combination of online material with students' real-life experiences in face-to-face settings using CBL (Breytenbach et al., 2017; McDonald & Boulton,

2018; Ota el at., 2018). E-learning must be implemented as it improves documentation competency and increases the student's knowledge of technology and computer skills as well as the accessibility of learning materials. In addition, CBL is important to encourage students to be active participants in developing critical skills and enhancing problem-solving skills for real-life problems, enhancing the integration of theoretical knowledge with clinical practice (Breytenbach et al., 2017).

Blended learning could also be referred to as the Blended On-Line and Digital (BOLD). Each letter of the BOLD acronym signifies a specific aspect of blended learning. The "B" stands for the word "Blended" and represents the combination of face-to-face and online learning that occurs within classrooms, clinical environments, and online settings. The "O" and "L" in the BOLD model represent the word "On-Line" and stand for the facilitation of learning through the use of technology and the Internet. Finally, the letter "D" represents the word "Digital" and relates to the wide range of technology used, including computers, mobile and other electronic devices (Ota et al., 2018). In this learning methodology, students read online material or watch videos prior to the class, since it has been reported to enrich the learning (Chan et al., 2016; McDonald & Boulton, 2018; Ota et al., 2018). In Ota et al. (2018), students using BOLD reported generally good experiences in linking online theory to practice.

Currently there is a lack of suitable e-contents specially adapted for nursing education (Pfefferle et al., 2010). Regarding sustainability, it can be only found the digital materials on environmental sustainability and nursing developed by NurSusTOOLKIT: A Teaching and Learning project. These are resource for sustainability in nursing, with the aim of achieving nursing training that is more in line with the environmental challenges that future nursing professionals will have to face using new information technologies (Álvarez-Nieto et al., 2018; NurSus, 2018).

2.2.4. Questionnaires to Assess Children´s Environmental Health Competencies among Nursing Students

Due to the importance of getting attitudes, knowledge and skills related to children´s environmental health, and the recent development of digital education materials on this topic, it is necessary evaluate the effectiveness of digital education to improve the children´s environmental health competencies among nursing students, defined as a set of related students nurses´ attitudes, knowledge and skills. It can be done by valid and reliable questionnaires.

To assess attitudes through the environment among nursing students, we found that some studies (Cruz, Alshammari & Felicilda-Reynaldo, 2018a; Felicilda-Reynaldo et al., 2018) used the New Ecological Paradigm scale that contains items on five dimensions of environmental attitudes: The reality of limits to growth, anti-anthropocentrism, the fragility of nature's balance, rejection of the idea that humans are exempted from the constraints of nature, and the possibility of an eco-crisis or ecological catastrophe. But we found one survey specially validated and developed for nursing students to assess attitudes toward sustainability and climate change, the Sustainability Attitudes in Nursing Survey 2 (SANS_2) (Richardson et al., 2016). SANS_2 has been used in different studies with nursing students (Richardson, Grose, Bradbury & Kelsey, 2017; Cruz et al., 2018a, 2018b).

In the knowledge case, one study (Felicilda-Reynaldo et al., 2018) used a knowledge questionnaire with Arabic nursing students, and this questionnaire was focusing on climate change knowledge, attitudes and perceptions of health impacts of climate change, and the role of nursing in addressing health impacts of climate change, in a general way with short affirmations. Nigatu et al. (2014) used a knowledge questionnaire among Ethiopian health science students to assess the awareness of climate change, student´ knowledge of the effect of climate change at their place of residence, health impacts of climate change, and possible effects of climate change. Richardson et al. (2014a) and Grose, Doman, Kelsey, Richardson & Woods (2015) assed the knowledge of nursing students after interventions related to sustainability in Plymouth University, but the questionnaire used consisted in three questions referring to awareness of peak oil, knowledge of service delivery resources and management of waste in healthcare. In Richardson et al. (2017) the knowledge acquired by the nursing students in a session with topics on sustainability was assessed with another questionnaire consisting in three questions referring to plastic provenance, cost of clinical waste and cost of domestic waste. In others occasions, the knowledge has been reported with qualitative methods in the literature (Richardson et al., 2014b). So, the existing questionnaires or methods to assess the knowledge on children´s environmental health are not adequate.

And in the skills case, it has not been found any questionnaire used to assess environmental skills in nursing.

2.2.5. Justification of the Study

It was showed that climate change is causing health problems. The pediatric population, especially children under five years old (Del-Río-Paredes, 2005), is the most vulnerable to exposure to environmental risk factors. Addressing children's vulnerabilities and decreasing their exposures require a multi-faceted and multi-disciplinary approach with clinical, public health, and policy interventions. The Institute of Medicine has recommended the integration of environmental health into nursing practice, education, research, and policy/advocacy work (Sattler & Davis, 2008). Health professionals therefore have an important role to play in understanding and communicating issues related to climate change to children and their families as serious damage to health is occurring (McBridge, 2016; Patz et al., 2014). Nurses must be fully educated in children's environmental health since during the different stages of children's growth and development, they can recognise the relevant risks to that age group and attempt to prevent and alleviate environmental hazards. But education on environmental aspects in the nursing curriculum is somewhat limited (McDermott-Levy et al., 2019).

The child health competencies deficits identified will require nurse education to take a strong lead in ensuring that nurses of the future are prepared to tackle environmental child health issues and this puts nurse education firmly in a key position to equip nurses with the knowledge and skills to pioneer innovative and creative responses to improving environmental child health (Richardson et al., 2014a; Sterling, 2012). Therefore, it becomes necessary to include environmental issues in undergraduate nursing education within the European Higher Education Area (Grande-Gascón, Álvarez-Nieto, Linares-Abad, López-Medina, Parra-Anguita & Álvarez-García, 2016; Goodman & East, 2014; McDermott-Levy et al., 2019; Richardson et al., 2014a), and tools to evaluate its effectiveness in increasing children's environmental health attitudes, knowledge and skills.

However, the tools that have been developed to measure knowledge about sustainability are focused in a general knowledge of the effect of climate change in the health. Scales or questionnaires must present psychometric properties of consistency in both reliability and validity (Polit & Beck, 2008); but only one of the knowledge questionnaires were validated (Felicilda-Reynaldo et al., 2018). In addition, any of the tools found were developed in the Spanish context, so could be cultural different. Besides, we could not find any tools to measure skills in sustainable among nursing students. It would be convenient to have questionnaires that would serve to value the knowledge and skills in the Spanish and British context.

Assessing and addressing the possible knowledge and skills deficit may be one of the keys to improving healthcare for children with environmental problems. In the absence of instruments for measuring knowledge of and skills in children´s environmental health, the construction and validation of two new questionnaires to measure these concepts is justified.

The scientific community and the different lecturers can use the information provided by the questionnaires to guide the contents of the educational programmes and future interventions. Initially the most feasible and beneficial would be to include issues about sustainability in the children's health course including theory, online materials, ICT and study cases (McDermott-Levy et al., 2019). And after the training, it is necessary to evaluate the perception of the students with it, in order to improve the educational strategies.

CHAPTER 3 HYPOTHESIS AND OBJECTIVES

Based on all the literature presented above, we propose the following hypotheses and objectives for this project.

3.1. Hypothesis

The hypotheses that want to be tested in this project are:

- The children´s environmental health competencies are insufficient among Spanish and English nursing students.
- Digital educational materials on children´s health and environment addressing to nursing will increase attitudes, knowledge and skills to manage children´s environmental health problems.
- The digital educational materials on children´s health and environment are perceived to be of high quality by nursing students.
- The children´s environmental health knowledge and skills questionnaires are valid and reliable tools for measuring the level of knowledge of and skills in children's environmental health among Spanish and English nursing students.

3.2. Objectives

The *general objectives* of the project are:

- Build and validate a knowledge questionnaire and a skills questionnaire on children's environmental health for Spanish and English nursing students.
- Determine the attitudes, knowledge and skills related to children´s environmental health of nursing students from different Spanish and United Kingdom universities.
- Evaluate the effectiveness of digital educational materials in training nursing students on children´s environmental health.
- Assess the quality of the digital educational materials on children´s health and environment perceived by nursing students.

The *secondary objectives* are:

- Build a knowledge questionnaire and a skills questionnaire on children´s environmental health in Spanish version.
- Develop and culturally adapt an English version of the knowledge questionnaire and the skills questionnaire on children's environmental health.
- Check the psychometric properties of the knowledge questionnaires and the skills questionnaire on children's environmental health in the university context of Spain and England.
- Assess the attitudes, knowledge and skills related to children´s environmental health of Spanish nursing students.
- Assess the improvement in attitudes, knowledge and skills related to children´s environmental health of university nursing students after exposure to the digital educational material.
- Determinate the perceived quality by nursing students of the digital educational materials on children´s health and environment in its didactic, technological and accessibility aspects.

CHAPTER 4 METHODOLOGY

This chapter presents the overall methodology of the project, which will be detailed in the different method sections of each of the chapters referring to the stages of the project.

4.1. Study Stages

The study was developed in four main stages:

1. An observational cross-sectional study to build and validate the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q) in the Spanish context, following four phases:
    - Phase 1: Development of the questionnaire and items wording
    - Phase 2: Content validation by an expert panel
    - Phase 3: Pilot test
    - Phase 4: Psychometric evaluation
2. An observational cross-sectional study to translate, adapt and validate the ChEHK-Q and the ChEHS-Q in the British context, following two phases:
    - Phase 1: Translation and adaptation process
    - Phase 2: Validation process
3. An observational multi-centre cross-sectional study to evaluate the attitudes, knowledge and skills of Spanish undergraduate nursing students.
4. A quasi-experimental study of time series using pre-post educational intervention evaluation. The groups were exposed to the educational material and the attitudes, knowledge and skills were measured before and after the exposure. A post-exposure measurement of the quality of educational material was undertaken.

4.2. Participants

The target population are undergraduate nursing students from Spain and the United Kingdom.

The sample for the first stage was undergraduate nursing students of the University of Jaén (Spain).

The sample for the second stage was undergraduate child health nursing students of the University of Plymouth (United Kingdom).

The sample for the third stage was undergraduate nursing students from eight Spanish universities: University of Almería, University of Cantabria, University of Córdoba, University of Granada, University of Jaén, University of Lleida, University of Málaga and University of Sevilla.

The sample for the fourth stage was undergraduate nursing students who were studying a child and adolescent nursing course at University of Jaén (Spain) and undergraduate child health nursing students of the University of Plymouth (United Kingdom).

All samplings were for convenience.

4.3. Study Variables

- Sociodemographic variables:
    - Age. Discrete quantitative variable. Expressed in number of years.
    - Gender. Nominal qualitative variable. Categories: Male, female, transgender.
    - Level of studies (highest course in which students are enrolled). Ordinal qualitative variable. Categories: 1st, 2nd, 3rd and 4th (4th course only among Spanish students).
    - Attended a session on sustainability and nursing (in the last 3 months). Nominal qualitative variable. Categories: Yes, no, yes but it has been over three months now.
- Independent variable:
    - Exposure to e-NurSus Children intervention. Dichotomous nominal qualitative variable. Categories: Exposed, no exposed.
- Dependent variables:
    - Level of attitude towards sustainability in nursing. Discrete quantitative variable. It has been assessed using the SANS_2. It is composed of five items whose response options range from one to seven on a Likert scale. The maximum score on the scale is 35 points. Reliability analysis revealed a Cronbach's alpha of 0.82,

and the five items loaded on a single factor explained 58% of the variance (Richardson et al., 2016).

- Level of knowledge about children's environmental health. Discrete quantitative variable. It has been assessed using the ChEHK-Q. This questionnaire has been built into this research ad hoc.
- Level of skills in children's environmental health. Discrete quantitative variable. It has been assessed using the ChEHS-Q. This questionnaire has been built into this research ad hoc.
- Quality level of digital educational material on children´s health and environment. Discrete quantitative variable. It was assessed with the questionnaire Quality of Digital Educational Materials (COdA). This questionnaire is included in a Spanish Standard (UNE 71362) on educational materials quality (Spanish Association for Standardization and Certification, 2017). COdA has 58 items grouped in 14 dimensions. Its response options range from one to ten on a Likert scale. The maximum score on the scale is 580 points.

4.4. Work Development

This study has been carried out in the following phases (Figure 4.1):

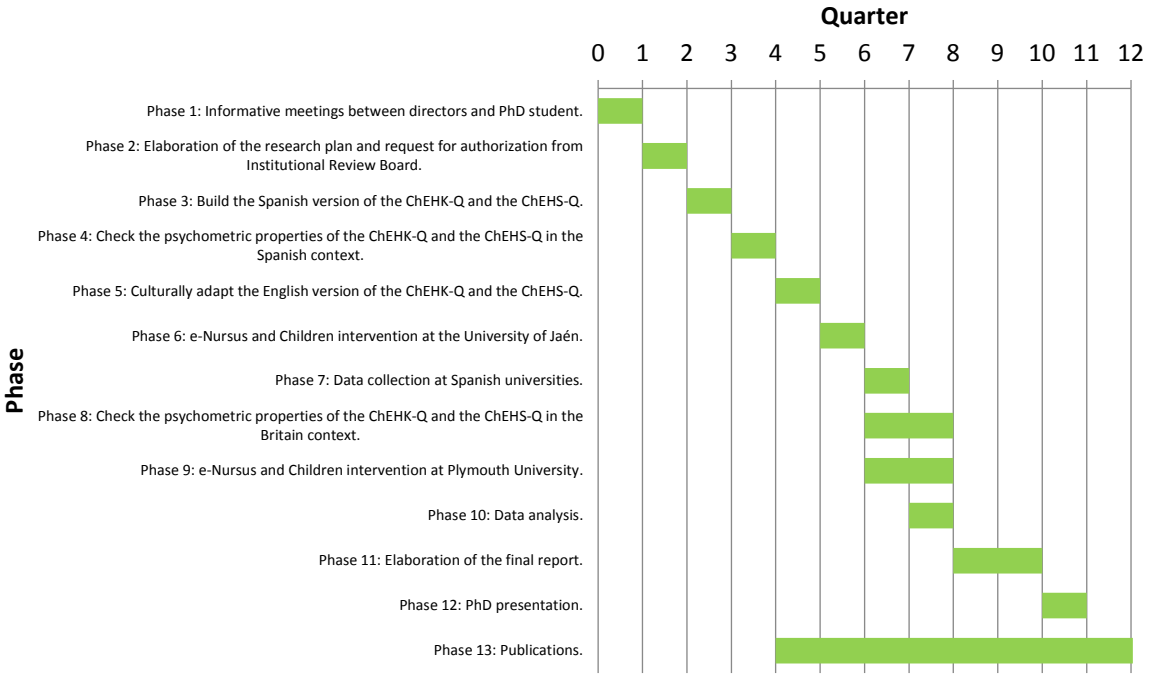

Figure 4.1. Work schedule.

4.5. Ethics

This study was approved by the Institutional Review Board of University of Jaén (Appendix 1) and University of Plymouth (Appendix 2). An information sheet was developed for participants in Spanish (Appendix 3) and English (Appendix 4). The students who completed the questionnaire only once, were explained the objectives of the research and the non-obligatory nature of participation in it; in addition, they were asked for verbal consent to participation and all their questions were answered. The students who participated in the e-NurSus Children intervention received an information sheet and signed the informed consent (Appendices 5 and 6) previous the session. The informant consents were stored in a secure location. Students were not obliged to fill out the questionnaires, and it did not affect the grade of any course. Participation was voluntary. Confidentiality of personal data were guaranteed.

CHAPTER 5 STAGE 1. Student Nurses´ Knowledge and Skills of Children´s Environmental Health: Instrument Development and Psychometric Analysis Using Item Response Theory

• Álvarez-García C, Álvarez-Nieto C, Pancorbo-Hidalgo PL, Sanz-Martos S, López-Medina IM. Student nurses´ knowledge and skills of children´s environmental health: instrument development and psychometric analysis using item response theory. Nurs Educ Today. 2018;69:113-9. https://doi.org/10.1016/j.nedt.2018.07.008

ABSTRACT

Background: Climate change has an important impact on health, particularly in children. Therefore, the inclusion of environmental issues in the undergraduate nursing curriculum is essential. Knowledge and skills in environmental sustainability can be measured through questionnaires.

Objectives: The aim of this study was to develop and validate the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q) to measure knowledge and skills, respectively, about children's environmental health in nursing students.

Design: This was an observational, cross-sectional study undertaken in four phases: (1) Development of the questionnaire and item wording, (2) content validation by an expert panel, (3) pilot test and (4) psychometric evaluation.

Settings: A Faculty of Health Sciences in Spain.

Participants: 308 nursing students enrolled in the first, third and fourth years of study.

Methods: The development and validation of the children's environmental health questionnaires was carried out based on the item response theory.

Results: The 26-item ChEHK-Q shows good fit and reliability of 0.98 for items and 0.70 for people based on the Rasch Model. The 12-item ChEHS-Q also shows good fit and reliability of 0.87 for items and 0.76 for people based on Andrich's rating scale model. The temporal stability measured using the intraclass correlation coefficient was 0.86 in the ChEHK-Q and 0.73 in the ChEHS-Q. Both questionnaires present enough evidence for construct validity; they work well to distinguish between nursing students with low or high knowledge of or skills in children's environmental health.

Conclusions: The Children's Environmental Health Knowledge Questionnaire and the Children's Environmental Health Skills Questionnaire are useful tools for measuring knowledge and skills, respectively, among nursing students. This validation study obtained good psychometric properties concerning validity and reliability.

CHAPTER 6 STAGE 2. Transcultural Adaptation of Children´s Environmental Health Questionnaires for British Nursing Student

• Álvarez-García C, Álvarez-Nieto C, Carter R, Kelsey J, Sanz-Martos S, López-Medina IM. Cross-cultural adaptation of children´s environmental health questionnaires for nursing students in England. Health Educ J. 2020;79(7):826-838. https://doi.org/10.1177/0017896920915594

ABSTRACT

Objectives: Children are among the most vulnerable population groups with regard to environmental risks. Nursing students must be fully educated on children's environmental health as they are in a key position to prevent and reduce the effects of environmental hazards. The main objective of this study was to adapt and validate an English language version of two questionnaires about children's health and the environment, to assess the knowledge and skills of student nurses in England.

Design: Observational cross-sectional study.

Setting: A university in Southern England.

Method: The study involves translating, adapting and validating the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q) with nursing students in England (N = 232).

Results: The psychometric characteristics of both questionnaires were strong. Infit and outfit values were close to 1. The reliability values for the items and people were 0.96 and 0.79 for ChEHK-Q and 0.98 and 0.89 for ChEHS-Q, respectively. Only 52 (22.41%) and 77 (33.62%) participants had at least good knowledge and skills, respectively. Higher knowledge and skills were found with respect to the vulnerability of children and identification of environmental risks in the home. Lower levels of knowledge and skills were found with respect to the effects of pesticides and the assessment of neoplastic pollutants.

Conclusion: Findings demonstrate deficiencies in nursing competencies related to children's environmental health. The use of these questionnaires will facilitate improvement in both knowledge and skills related to children's environmental health among future nurses.

CHAPTER 7 STAGE 3. Undergraduate Nursing Students' Attitudes, Knowledge and Skills of Children´s Environmental Health: A Multicenter Cross-Sectional Study

• Álvarez-García C, Álvarez-Nieto C, Sanz-Martos S, Puente-Fernández D, López-Leiva I, Gutiérrez-Puertas L,… López-Medina IM. Undergraduate nursing students' attitudes, knowledge and skills of children´s environmental health. J Nurs Educ. 2019;58(7):401-408. https://doi.org/10.3928/01484834-20190614-04

ABSTRACT

Background: Nurses are in a privileged position to detect environmental risks among children. The objective was to determine attitudes, knowledge, and skills related to children's environmental health in undergraduate nursing students.

Method: A cross-sectional study was designed in eight universities (n = 2,462) from September 2017 to June 2018. Descriptive values and multivariate analysis of variance were calculated using three questionnaires.

Results: Of the total 2,462 students in the sample, 2,155 had a good attitude regarding addressing children's environmental health problems, 501 had good knowledge, and 1,162 had good skills. Students who had attended a session on sustainability more than 3 months prior had a better attitude (9.93%), knowledge (11.16%), and skills (3.82%). Second course students and men had better environmental competency ($p < .001$).

Conclusion: Undergraduate nursing students have good attitudes; however, they lack knowledge and skills. There is a need to include children's environmental health in nursing curricula.

CHAPTER 8 STAGE 4. Effectiveness of the e-NurSus Children Intervention in the Training of Nursing Students

• Álvarez-García C, Álvarez-Nieto C, Kelsey J, Carter, R, Sanz-Martos S, López-Medina IM. Effectiveness of the e-Nursus children intervention in the training of nursing students. Int J Environ Res Public Health. 2019;16(21):4288. https://doi.org/10.3390/ijerph16214288

ABSTRACT

The paediatric population is the most vulnerable to exposure to environmental risk factors. Institutions of higher education have to equip nursing students with the attitudes, knowledge, and skills to respond to this using blended learning. The aim of this study was to evaluate the effect of e-NurSus Children intervention on student nurses' attitudes, knowledge, and skills. A quasi-experimental study of time series was designed using pre and post educational intervention evaluation in 2018. The participants were nursing students (N = 267) from Spain (n = 110) and the United Kingdom (n = 157). Three instruments were used: the Sustainability Attitudes in Nursing Survey, the Children's Environmental Health Knowledge Questionnaire, and the Children's Environmental Health Skills Questionnaire. The attitudes (15.81%), knowledge (39.02%), and skills (29.98%) of nursing students improved following the e-NurSus Children intervention. It is necessary to include topics on children's environmental health in nurse education as students are aware of this issue but do not have the knowledge or skills required to manage problems or illness caused by the environment. The e-NurSus Children intervention is an effective tool to address this educational gap.

CHAPTER 9 CONCLUSIONS

1. The ChEHK-Q is a valid and reliable tool for measuring knowledge of children´s environmental health among Spanish and British nursing students.
2. The ChEHS-Q is a valid and reliable self-reported scale for measuring Spanish and British student confidence in their skills.
3. The use of the ChEHK-Q and the ChEHS-Q may help to guide the teaching-learning process in children's environmental health higher education.
4. Child health nursing students from University of Plymouth need more training to manage environmental problems or illness in children. Only 22.41% of the Plymouth nursing students had good children's environmental health knowledge. And only 33.62% of the Plymouth nursing students had good children's environmental health skills. In contrast, the 97.45% of the Plymouth nursing students had good children's environmental health attitudes.
5. The Plymouth nursing students are knowledgeable of the especial children vulnerability toward the problems caused by the environment and they have good skills to identify environmental risks. But they do not have enough knowledge about the effects of pesticides and neoplastic pollutants and how to manage these expositions. Besides, they think that sustainability is an important issue for nursing and should be included in the nursing curriculum.
6. Spanish student nurses have positive attitudes toward dealing with environmental problems (87.53% had at least good attitudes), but they lack knowledge (only 20.35% had at least good knowledge) and skills (only 47.20% students had at least good skills) to deal environmental problems.
7. Spanish nursing students consider that climate change is an important issue for nursing but they are showed reluctant to include climate change in the nursing curriculum. They know children vulnerability, but they do not know the effects of nitrogen oxide and food colourings and preservatives in the children health. They are able to assess environmental respiratory diseases, but they have difficulties assessing environmental neoplastic risks.
8. Among Spanish students, the children´s environmental health competencies were lower in women than in men, in first course < fourth course < third course < second course, in students who had not attended a session on sustainability and nursing versus

students who had attended a session within the past three months versus students who had attended it but more than three months prior, and in Jaén and Granada versus Almeria, Cantabria, Córdoba, Lleida, Málaga and Sevilla.

9. The e-NurSus Children intervention is useful to increase the attitudes, knowledge and skills related to children's environmental health between nursing students, so it is useful to increase the children´s environmental health competencies. In University of Jaén, skills improved the most (42.33%), followed by knowledge (37.61%) and attitudes (22.96%). In University of Plymouth, knowledge (40.38%) improved the most, followed by skills (21.70%) and attitudes (11.06%).
10. The quality of the educational materials used during the interventions was above average in all cases. In University of Jaén, *Accessibility of textual content* was the highest dimension, 9.07, and the lowest was *Portability*, 8.22. In University of Plymouth, *Workability* was the highest, 7.12, and the lowest was *Interactivity*, 6.17.
11. These findings clearly show the necessity to change the nursing curricula and include topics on children's environmental health, because nursing students have positive attitudes toward sustainability but do not have the knowledge and skills needed to manage problems or illness caused by the environment.

CHAPTER 10 IMPLICATIONS FOR NURSING PRACTICE

This research provides two new valid and reliable tools to measure knowledge of and skills in children's environmental health among nursing students. The ChEHK-Q and ChEHS-Q measure the latent traits “knowledge of children's environmental health” and “skills in children's environmental health”, respectively, to rank nursing students in the Spanish and English speaking context. The ChEHK-Q was designed as a 26-item questionnaire, and the ChEHS-Q was designed as a 12-item questionnaire and they can be self-administrated. As both tools are one-dimensional, the scores can be calculated just by adding up the number of correct answers in ChEHK-Q or by adding up the scores obtained on the Likert scale in ChEHS-Q. The questionnaires are available online or on paper in Spanish and English for the global scientific community to use with nursing students.

Descriptive analysis showed concerned values among Spanish and British nursing students since the most of the nursing students didn´t have enough knowledge and skills, but they had good attitudes through environmental problems. The problem is greater in the case of knowledge, making us realize that including topics related to how the environment affects child health is highly important because nursing students have sufficiently positive attitudes about the important of these topics but need more knowledge to develop skills in this field. The values were similar in Spain and United Kingdom, but they were more concerned in United Kingdom. Our results are not entirely discouraging, since environmental attitudes among nurses are the first step in enhancing nurses and nursing students’ awareness about the risks which the environment could have in the health and how to prevent and treat those applying sustainable cares. Nursing students with higher children´s environmental health competencies were found in cities where the local government has developed plans and policies to achieve more sustainability. These make us realize about the importance of promoting politics changes.

In this study, after the intervention in Spain and United Kingdom, attitudes, knowledge and skills was significant higher in both cases. Less demonstrated improvement in attitudes could have been caused because attitudes were high before the intervention. In the descriptive analysis, the values were more positives in Spain, since the intervention was a compulsory seminar inside the nursing curriculum.

The ChEHK-Q and the ChEHS-Q could be used to determine whether the inclusion of issues related to children's environmental health problems in the nursing curriculum is associated with an increased score in these questionnaires. Besides, the ChEHK-Q and the ChEHS-Q would be useful for assessing knowledge and skills before and after educational sessions. The interventions could be developed inside the nursing curricula to improve student nurses´ knowledge and skills in different European universities, since it was showed positive in our study. The future objective is adapting the content in undergraduate and postgraduate education to our present reality, following the numerous regulations across Europe that support it. Our study supports starting to include sustainable topics in the first course of the nursing degree.

Among pediatric nurses working in healthcare centers, ChEHK-Q and ChEHS-Q could be validated to determine their knowledge of and skills in children's environmental health. Also, they could be used before and after initiatives to increase register nurses training in this area.

The promotion of such studies may help to determine which learning and teaching methods are more effective to increase the knowledge and skills of nurses with regards to problems in children's environmental health. The NurSusTOOLKIT material could be used to improve the deficient areas, since our study has proved that this material has an adequate quality to improve the children´s environmental health competencies.

This research provides a significant reflection on learning processes in the current educational system and how to improve them through the implementation of environmental sustainability within the context of the European Higher Education Area. University nursing training should include environmental issues, both conceptually and practically, and both transversally and specifically. The use of the ChEHK-Q and the ChEHS-Q may help to guide the teaching-learning process in children’s environmental health higher education.

Although further work is required, our findings clearly show the necessity to change the nursing curricula and include topics on children’s environmental health, as nursing students feel this necessity but do not have the knowledge and skills needed to manage problems or illness caused by the environment. It is highly important to develop approaches to change this reality—climate change is advancing, so nursing must advance with it. The e-NurSus Children intervention is useful to increase the attitudes, knowledge and skills related to children’s environmental health among nursing students. It has used a blended-learning approach that combines theory, use of ICT and case studies. Accordingly, student nurses have an opportunity to think more

broadly about the impact of climate change in children's health and what solutions could be implemented at personal, local, national and international level.

10.1. Future Research Lines

A researcher from Manisa Celal Bayar University, Turkey, is currently translating and culturally adapting ChEHK-Q and ChEHS-Q to the Turkish context. In June, Cristina Álvarez García will begin a two-month stay at Kocaeli University, Turkey, to carry out the translation and cultural adaptation of SANS_2 to the Turkish context. Besides, she will collect data with the three questionnaires (SANS_2, ChEHK-Q and ChEHS-Q) once the adaptation process has been completed. Other researchers from Finland and Sweden have shown interest in collecting data on children's environmental health competencies among undergraduate nursing students. We are currently looking for more agreements with researchers from other countries. The data collected is intended to conduct an international study of children's environmental health competencies in different countries.

At national level, we have planned a multi-centre study to implement the e-NurSus Children intervention in different Spanish universities. In the current academic year data have been collected at the Catholic University of Murcia, and in the following year data will be collected at University of Almería, University of Cantabria, University of Granada and University of Lleida.

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CHAPTER 12 APPENDICES

12.1. APPENDIX 1

UNIVERSIDAD DE JAÉN
Vicerrectorado de Investigación

Campus Las Lagunillas, s/n- Edificio B-1
Tlf. 953/212597- Fax 953/211968
E-mail vicinv@ujaen.es
23071 Jaén

De: Vicerrectorado de Investigación,
A: Cristina Álvarez García
Jaén a 28 de abril de 2017

Por indicación de la Vicerrectora de Investigación, adjunto se remite informe favorable solicitado por usted del Comité de Ética.

Atentamente,

Mª. Pepa González Rubia
Secretaria de Apoyo a Órganos de Gobierno

UNIVERSIDAD DE JAÉN
Vicerrectorado de Investigación

COMISIÓN DE ÉTICA

Tipo de actividad : Proyecto de tesis

Referencia: ABR.17/1

Título de la actividad: Efectividad de un material educativo digital sobre salud medioambiental infantil en la formación de estudiantes de enfermería

Convocatoria y/o entidad a la que se presenta: Tesis doctoral

- Solicitante : Cristina Alvarez Garcia

Tipo de experimentación o actividad sometida a informe: Investigación en humanos: entrevistas, encuestas y test

Informe que se emite : FAVORABLE

Observaciones:

Jaén, 25 de abril de 2017

Amelia Aránega Jiménez
Presidenta de la Comisión de Ética

Vicerrectorado de Investigación
Campus Las Lagunillas, s/n. Edificio B-1 Rectorado – Telf. 953 212587 – Fax 953 211968 – E-mail: vicinv@ujaen.es

12.2. APPENDIX 2

RESEARCH WITH PLYMOUTH UNIVERSITY

24th April 2018

CONFIDENTIAL

Professor Janet Richardson
School of Nursing and Midwifery
Fourth floor Rolle Building
University of Plymouth
Drake Circus
PL4 8AA

Dear Janet,

Application for Approval by Faculty Research Ethics and Integrity Committee

Reference Number: **17/18-889**
Application Title: **Effectiveness of a digital educational material about environmental health in the training of nursing students.**

I am pleased to inform you that the Committee has granted approval to you to conduct this research.

Please note that this approval is for one year (until 23rd April 2019), after which you will be required to seek extension of existing approval.

Please note that should any MAJOR changes to your research design occur which effect the ethics of procedures involved you must inform the Committee. Please contact Maurice Bottomley (email hhsethics@plymouth.ac.uk).

Yours sincerely

Professor Paul H Artes, PhD MCOptom
Professor of Eye and Vision Sciences
Co-Chair, Research Ethics Committee -
Faculty of Health & Human Sciences and
Peninsula Schools of Medicine & Dentistry

Faculty of Health & Human Sciences
Plymouth University
Drake Circus
Plymouth PL4 8AA

T +44 (0)1752 585339
F +44 (0)1752 585328
E hhsethics@plymouth.ac.uk
W www.plymouth.ac.uk

Professor Paul H Artes, PhD
Co-Chair, Faculty HHS REB

12.3. APPENDIX 3

HOJA DE INFORMACIÓN A LOS PARTICIPANTES

El título de esta investigación es "Efectividad de un material educativo digital sobre salud medioambiental infantil en la formación de estudiantes de enfermería". Se llevará a cabo en la Universidad de Jaén y la Universidad de Plymouth. Su objetivo es evaluar la efectividad de un material educativo digital para aumentar los conocimientos, actitudes y habilidades sobre salud medioambiental infantil y determinar la calidad del material educativo digital, y así poder valorar la adecuación de los materiales educativos que se están usando para dar a conocer este fenómeno. Los participantes en este estudio serán así conscientes de qué saben sobre este tema para poder mejorar sus conocimientos en las áreas que se encuentren deficitarias. Este estudio cuenta con el informe favorable del Comité de Bioética de la Universidad de Jaén.

Los datos se obtendrán mediante la cumplimentación de unos cuestionarios. El tiempo necesario para responderlos oscilará entre 10 y 15 minutos. Existe la posibilidad de ser contactado con posterioridad a fin de recabar nuevos datos, para lo que podrá solicitársele información sobre el modo de hacerlo.

Se respetará el principio de Autonomía, ya que será imprescindible que los participantes presenten el consentimiento informado firmado, así como su consentimiento verbal a participar. En todo momento se podrá revocar el consentimiento y sus efectos, incluida la posibilidad de la destrucción o de la anonimización de la muestra, pero tales efectos no se extenderán a los datos resultantes de las investigaciones que ya se hayan llevado a cabo.

Los datos obtenidos mediante la cumplimentación del cuestionario, serán privados y confidenciales, quedando almacenados en una base de datos especialmente diseñada para esta investigación. El análisis de la información obtenida se realizará identificando a cada participante con un código y los datos serán tratados de forma agregada. Los datos podrán ser usados en posteriores investigaciones, informándose previamente de ello, cumpliendo los requerimientos previstos en la ley 14/2007.

Las investigadoras responsables de este proyecto son Carmen Álvarez Nieto, Isabel M. López Medina y Cristina Álvarez García. En caso de cualquier duda, enviar un correo a cagarcia@ujaen.es o llamar al 601044275.

12.4. APPENDIX 4

INFORMATION SHEET FOR PARTICIPANTS

The main researcher for this project is Professor Janet Richardson. She may be contacted by email on, janet.richardson@plymouth.ac.uk. You may also choose to contact the researcher from the Spanish team Cristina Álvarez García on email, cristina.alvarezgarcia@plymouth.ac.uk.

The title of this research is "Effectiveness of a digital educational material on children's´ environmental health in the training of nursing students". This research will take place in both University of Jaén and University of Plymouth. The aim is to evaluate the impact of a taught session with the module of the NurSusTOOLKIT: Children's' Environmental Health on student nurses' attitudes, knowledge and skills.

What you are being asked to do

You are being asked to take part in a teaching session involving a short power-point presentation, discussion around issues raised and some work with online digital materials. You will be asked to complete pre and post on line questionnaires related to the session. The teaching session will take approximately 1.5 hours. The time needed to respond to the questionnaire will vary between 10 and 15 minutes. The total time required will be approximately 2 hours. You may be asked if you can be contacted after completing the questionnaire in order to obtain new data, and you will be asked how that can be achieved. You may refuse further contact at any point in this study. Your participation in the investigation may finish at any time if there is reason to suspect that, if it continues, it could cause you some type of injury or unnecessary discomfort.

What the data will be used for

The data will be used for assessing student nurses' attitudes, knowledge and skills on children's environmental health. Besides, we want to assess the quality of the educational materials used in the educational sessions. The results will be included in a doctoral thesis report.

The analysis of obtained information will be carried out identifying each subject with a number hence ensuring anonymity. The data will be combined and may be used in further investigations following on from this study. Anonymity will be maintained at all times.

Data store

The consent forms and data obtained by completing the questionnaires will be private and confidential, and stored in a database specially designed for this research. It will be stored in digital and where required paper format, in a locked filing cabinet on a password protected device in a locked office both at the University of Plymouth and University of Jaen. It will be stored for three years and then destroyed.

Participants´ rights

The principle of autonomy will be respected, you will be asked for signed informed consent prior to participation, in addition, you will be asked to confirm this consent at the beginning of both pre and post questionnaires. Consent and use of data, including the possibility of destruction or anonymity of the sample, may be revoked at any time, but this shall not extend to data resulting from investigations that have already been carried out. You may refuse to participate at any time. In the case of an unforeseen effect of taking part in this study, the principle researcher may be contacted via email at janet.richardson@plymouth.ac.uk. If it is identified that any participant may have been disadvantaged due to taking part in the study, appropriate measures will be taken to mitigate such disadvantage. Your consent could be requested again if data were used in subsequent studies and you may refuse this at any time. The confidentiality of the information obtained is guaranteed, the only people with access to personal data will be Janet Richardson, Janet Kelsey, Rachel Carter, Isabel Mª López Medina, Carmen Álvarez Nieto and Cristina Álvarez García. You may contact the Research Administrator to the Faculty Research Ethics Committee on hhsethics@plymouth.ac.uk should you have any concerns about the management of this study.

12.5. APPENDIX 5

CONSENTIMIENTO INFORMADO

Datos del estudio para el que se otorga el consentimiento

Investigadoras principales: Carmen Álvarez Nieto, Isabel M. López Medina y Cristina Álvarez García

Titulo proyecto: Efectividad de un material educativo digital sobre salud medioambiental infantil en la formación de estudiantes de enfermería.

Datos del participante

Apellidos. Nombre y DNI:

1. Declaro que he leído la Hoja de Información al Participante sobre el estudio citado.

2. Se me han explicado las características y el objetivo del estudio y los posibles beneficios y riesgos del mismo.

3. He contado con el tiempo y la oportunidad para realizar preguntas y plantear las dudas que poseía. Todas las preguntas fueron respondidas a mi entera satisfacción.

4. Se me ha asegurado que se mantendrá la confidencialidad de mis datos.

5. El consentimiento lo otorgo de manera voluntaria y sé que soy libre de retirarme del estudio en cualquier momento del mismo, por cualquier razón y sin que tenga ningún efecto sobre mis futuras calificaciones.

DOY □

NO DOY □

Mi consentimiento para la participación en el estudio propuesto

Fecha:

Firma del participante:

12.6. APPENDIX 6

INFORMED CONSENT

Data from the study for which consent is given

Principal Researcher: Professor Janet Richardson / Cristina Álvarez García

Project title: Effectiveness of a digital educational material on children's environmental health in the training of nursing students.

Centre: School of Nursing and Midwifery

1. I declare that I have read the Participant Information Sheet on the study cited.

2. I have been given a copy of the Participant Information Sheet and a copy of this Informed Consent, dated and signed. I have been explained the characteristics and the objective of the study and the possible benefits and risks of the same.

3. I have had the time and opportunity to ask questions and doubts I had. All the questions were answered satisfactorily.

4. I have been assured that my data will be kept confidential.

5. I give the consent voluntarily and I know that I am free to withdraw from the study at any time, for any reason and without having any effect on subject grades.

I GIVE □

I DO NOT GIVE □

My consent for the incorporation of the data to the Collection of Plymouth University and University of Jaén

Details of the participant

Surname, Name and ID:

Date:

Signature of participant

12.7. APPENDIX 7

MATRIX OF CONSTRUCTION OF THE KNOWLEDGE ITEMS

Variable: Knowledge of children's environmental health			
Dimensions	**Indicators**	**Items**	
Climate change and children's health	Children's environmental health	1. Environmental quality is a key factor for child´s survival.	True
		2. Emerging diseases are partially associated with environmental pollution.	True
	Child vulnerability	3. The paediatric population is one of the population groups most vulnerable to environmental threats.	True
		4. The paediatric population is more susceptible to environmental threats due to its biological immaturity.	True
		5. The increased energy and metabolic consumption of the paediatric population protects children from environmental hazards.	False
		6. The paediatric population is more vulnerable because of its inexperience in self-protection.	True
		7. Children have considerably more potential years of life ahead of them, and can therefore develop medium- and long-term effects from chronic low-dose exposures of environmental pollutants.	True
		8. Children do not have decision-making power in relation to the environmental issues that affect them more seriously than adults and that irreversibly compromise their future habitats.	True
		9. Increased cell growth in paediatric years increases the risk of health effects from environmental factors.	True
	Development of germ cells	10. Fetal damage may result from previous parental toxic exposure.	True
	Embryonic and fetal development	11. The effects of exposure to air pollutants on fetal development may result in increased mortality.	True
	Puberty	**12. Hormone-releasing organs may be affected by environmental factors.**	True
Environmental Factors in Chronic Childhood Illnesses	Environmental factors in chronic diseases	13. Chronic respiratory, neoplastic and neurological diseases associated with environmental pollution are emerging in childhood.	True
	Respiratory diseases	**14. Poor domestic air quality is associated with asthma, bronchitis and pneumonia.**	True
	Tobacco smoke	15. Exposure to tobacco smoke is responsible for 80% of persistent asthma in children under 6 years of age.	True
	Volatile organic substances	**16. Chronic exposure to volatile organic compounds, such as benzene and vinyl chloride, can cause cancer.**	True
	Nitrogen oxide	**17. Nitrogen oxides cause skin redness and burns.**	False
	Allergens	**18. Allergens cause or aggravate asthma attacks.**	True
	Mould spores	**19. Household humidity decreases childhood asthma attacks.**	False
		20. Spores can cause respiratory conditions or exacerbation of asthma symptoms.	True
	Ozone	**21. Ozone reduces lung function in children, especially in the winter months.**	False

	Carbon monoxide	22. Children living less than 500 metres from motorways or large traffic areas are susceptible to substantial loss of lung capacity at 18 years of age.	True
	Nitrogen oxide	23. Prolonged exposure to nitrogen oxide can affect the immune system and the growth of the lungs.	True
	Sulphur dioxide	24. Sulphur dioxide causes bronchoconstriction, increased lung clearance and lung infections.	False
	Indoor tobacco smoke	**25. Passive smoking is associated with numerous neoplasms.**	True
	Radon	**26. There are higher incidence rates of leukaemia in areas with greater exposure to radon.**	True
	Absent	27. Asbestos is associated with pulmonary and abdominal mesothelioma and lung cancer.	True
	Ultraviolet radiation	**28. Overexposure to solar ultraviolet radiation can damage the skin of adults to a greater extent than that of children**	False
	Hazardous waste stored	29. Children from marginal populations living in areas close to hazardous waste deposits or discharges are exposed to higher concentrations of carcinogens through the air, water and food they consume.	True
	Lead	**30. Lead accumulates in the body and it affects various systems.**	True
	Mercury	**31. Chronic exposure to mercury through diet (fish and shellfish) is less toxic to the central nervous system of children than it is to adults.**	True
	Manganese	32. Excessive and prolonged inhalation of manganese can cause hyperactivity and learning disorders.	True
	Cadmium	33. High levels of cadmium exposure, through diet or inhalation of tobacco smoke, can cause disorders of hyperactivity and infant learning.	False
	Polluted air	34. Exposure to polluted air, related to traffic during pregnancy or lactation, has been linked to cognitive delays in children.	True
	Pesticides	**35. Pesticide exposure increases attention problems in preschool and school.**	True
	Nicotine	**36. Children of mothers who smoke during pregnancy are at higher risk for hearing problems.**	False
	Solvents	**37. Exposure to organic solvents during development can lead to congenital malformations.**	True
	Fluoride	38. Fluoridation of drinking water can adversely affect fetal neurodevelopment.	True
Environmental pollution and infant feeding	Water pollution	**39. Water contaminated with nitrates can cause intoxication, mainly in children older than 6 months.**	False
	Radon	40. Water contaminated with radon may release contaminating particles.	True
	Water chlorination	41. Chlorination of water forms by-products of disinfection, classified as carcinogenic.	True
	Pesticides	**42. The greatest source of pesticide exposure among children is through the air they breathe.**	False
	Mercury	**43. The main route of exposure to mercury is through cereal intake.**	False
	Lead	**44. Dietary exposure to lead occurs mainly through fish intake.**	False
	Persistent organic pollutants	45. Digoxins accumulate in adipose tissue.	True

	Mycotoxins	46. Mycotoxins are present in many agricultural products, especially peanuts, nuts and cereals.	True
	Radioactive isotopes	47. Radioactive isotopes are introduced into the food chain through vegetables and cow's milk.	True
	Food Additives	**48. Some food additives can affect the central nervous system.**	True
	Genetically modified food	**49. Genetically modified organisms produce fewer allergic reactions.**	False
	Organic food	50. It has been shown that organic food is healthier than conventional food.	False
Types of Environments and Contaminants	MEME Model	51. Very specific health results can be attributed to a large number of different exposures.	True
	Exposure to pollutants at home	52. The release of energy from electric currents from our homes is harmless to child body.	False
	Exposure to pollutants at school	53. Physical, chemical, biological and social environmental risks can be found in schools.	True
	Exposure to pollutants in the environment	**54. Children are potentially exposed to higher concentrations of air pollutants at home than outdoors.**	False
		55. Parks and gardens are the most environmentally pollutant-free play areas.	False

Note. Items selected after using Flesch-Szigriszt formula are in bold.

12.8. APPENDIX 8

ChEHK-Q: AIKEN´S *V* SPREADSHEET FOR RELEVANCE

	Expert									
Item	1	2	3	4	5	6	*M*	Aiken´s *V*	95% *CI*	
1	5	5	5	5	5	4	5	.96	.79	.99
2	5	5	4	5	3	4	4	.83	.64	.93
3	5	5	5	5	5	5	5	1	.86	1
4	5	5	4	5	3	5	5	.88	.69	.95
5	5	5	5	5	5	5	5	1	.86	1
6	5	5	4	5	5	4	5	.92	.74	.97
7	5	5	5	5	2	4	4	.83	.64	.93
8	5	5	5	3	5	5	5	.92	.74	.97
9	5	5	5	5	3	5	5	.92	.74	.97
10	5	4	4	5	3	4	4	**.79**	**.59**	.90
11	5	5	4	5	5	5	5	.96	.79	.99
12	5	5	4	5	5	4	5	.92	.74	.97
13	5	5	5	5	5	5	5	1	.86	1
14	5	4	5	5	5	5	5	.96	.79	.99
15	5	5	4	5	5	5	5	.96	.79	.99
16	5	5	5	5	5	5	5	1	.86	1
17	4	5	4	5	4	5	5	.88	.69	.95
18	5	5	5	5	5	3	5	.92	.74	.97
19	5	5	4	5	5	5	5	.96	.79	.99
20	5	5	4	5	5	5	5	.96	.79	.99
21	4	4	4	5	5	5	5	.88	.69	.95
22	5	5	5	5	5	5	5	1	.86	1
23	5	5	5	5	3	5	5	.92	.74	.97
24	5	4	4	5	3	4	4	**.79**	**.59**	.90
25	5	5	5	5	5	5	5	1	.86	1
26	5	5	5	5	5	5	5	1	.86	1

Note. Values exceeding the limits set for Aiken´s *V* (.80 and .60 in the lower threshold of the 95 % *CI*) are in boldface.

12.9. APPENDIX 9

ChEHK-Q: AIKEN´S *V* SPREADSHEET FOR CLARITY

	Expert									
Item	1	2	3	4	5	6	*M*	Aiken´s *V*	95% *CI*	
1	5	5	5	5	5	3	5	.92	.74	.97
2	5	4	4	5	5	4	5	.88	.69	.95
3	5	5	5	5	3	5	5	.92	.74	.97
4	5	5	4	4	5	4	5	.88	.69	.95
5	5	2	5	4	5	5	4	.83	.64	.93
6	5	5	5	5	5	4	5	.96	.79	.99
7	5	5	4	4	5	5	5	.92	.74	.97
8	5	2	5	5	5	5	5	.88	.69	.95
9	5	5	5	4	5	5	5	.96	.79	.99
10	5	5	3	5	5	5	5	.92	.74	.97
11	5	5	5	5	4	5	5	.96	.79	.99
12	5	5	4	5	5	5	5	.96	.79	.99
13	5	4	5	5	5	5	5	.96	.79	.99
14	5	5	5	5	3	5	5	.92	.74	.97
15	5	5	5	5	5	5	5	1	.86	1
16	5	2	5	5	5	5	5	.88	.69	.95
17	5	5	4	5	5	5	5	.96	.79	.99
18	4	5	4	5	5	4	5	.88	.69	.95
19	5	5	4	5	5	5	5	.96	.79	.99
20	5	5	5	5	5	5	5	1	.86	1
21	5	5	4	5	5	5	5	.96	.79	.99
22	5	5	5	5	5	5	5	1	.86	1
23	5	5	3	4	5	5	5	.88	.69	.95
24	5	5	4	5	5	5	5	.96	.79	.99
25	5	5	5	5	5	5	5	1	.86	1
26	5	5	5	5	4	5	5	.96	.79	.99

12.10. APPENDIX 10

ChEHS-Q: AIKEN´S *V* SPREADSHEET FOR RELEVANCE

	Expert									
Item	1	2	3	4	5	6	*M*	Aiken´s *V*	95% *CI*	
1	5	5	5	5	5	5	5	1	.86	1
2	5	5	5	5	5	5	5	1	.86	1
3	5	5	5	5	5	5	5	1	.86	1
4	5	5	5	5	5	5	5	1	.86	1
5	5	5	5	5	5	5	5	1	.86	1
6	5	5	5	5	5	5	5	1	.86	1
7	5	5	5	5	5	5	5	1	.86	1
8	5	5	5	5	5	5	5	1	.86	1
9	5	5	5	5	5	5	5	1	.86	1
10	5	5	5	5	5	5	5	1	.86	1
11	5	5	5	5	5	5	5	1	.86	1
12	5	5	5	5	5	5	5	1	.86	1

12.11. APPENDIX 11

ChEHS-Q: AIKEN´S *V* SPREADSHEET FOR CLARITY

	Expert									
Item	1	2	3	4	5	6	*M*	Aiken´s *V*	95% *CI*	
1	5	4	5	5	3	5	5	.88	.69	.95
2	5	5	4	3	5	5	5	.88	.69	.95
3	5	5	5	4	5	5	5	.96	.79	.99
4	5	5	5	5	5	5	5	1	.86	1
5	5	5	5	3	5	5	5	.92	.74	.97
6	5	5	5	4	5	5	5	.96	.79	.99
7	5	5	5	5	5	5	5	1	.86	1
8	5	5	5	5	5	5	5	1	.86	1
9	5	5	5	5	5	5	5	1	.86	1
10	5	5	4	5	4	4	5	.88	.69	.95
11	5	5	4	5	5	4	4	.88	.69	.95
12	5	5	5	4	5	5	5	.96	.79	.99

12.12. APPENDIX 12

ChEHK-Q: INDEX OF DIFFICULTY AND DISCRIMINATION AND ITEM-TOTAL CORRELATION IN THE PILOT TEST

	Item	dI	ID	I-T
1.	Exposure to environmental risks in childhood determines a child's potential life years.	.98	.26	-.01
2.	The paediatric population is more susceptible to environmental threats due to their biological immaturity.	.99	0	-.01
3.	The increased energy and metabolic consumption of the paediatric population protects children from environmental hazards.	.93	.18	.37*
4.	The higher rate of cell growth during the paediatric age increases the risk of health effects caused by environmental factors.	.98	.03	.05
5.	During puberty, hormone secretion is not negatively affected by environmental factors.	.98	.03	.05
6.	Poor domestic air quality is related to the most prevalent childhood respiratory pathologies (such as asthma, bronchitis or pneumonia).	.98	-.08	-.18*
7.	Chronic exposure to volatile organic compounds, such as benzene and vinyl chloride, can cause cancer.	.99	0	-.01
8.	Nitrogen oxide causes skin redness and burns.	.15	.32	.35*
9.	Allergens aggravate asthma attacks.	.99	.03	.06
10.	Household humidity decreases childhood asthma attacks.	.88	.13	.15
11.	Passive smoking is associated with numerous cancers (such as acute leukemias).	.94	.03	.07
12.	There are higher incidence rates of leukaemia in areas with greater exposure to radon.	.91	.18	.24*
13.	Overexposure to solar ultraviolet radiations can damage the skin of adults more severely than that of children.	.82	.32	.43*
14.	During childhood more than half of the expected lifetime solar ultraviolet radiation is absorbed.	.99	.03	.06
15.	Lead accumulates in the body, affecting various systems, especially the nervous system.	.98	.08	.28*
16.	Chronic dietary exposure to mercury (fish and shellfish) is less toxic to children's central nervous system than to adults.	.96	.11	.35*
17.	Pesticide exposure increases attention problems in schoolchildren.	.97	.03	.05
18.	Sons and daughters of mothers who smoke during pregnancy are at greater risk of hearing problems.	.24	.34	.26*
19.	Exposure to organic solvents during development can lead to congenital malformations.	.98	.05	.23*
20.	Water contaminated with nitrates can cause intoxication, mainly in children older than 6 months.	.12	.08	.17*
21.	Chlorination of water forms sub-products from the disinfection process that have been classified as carcinogenic.	.98	.08	.05
22.	The major source of child exposure to pesticides is through the air they breathe.	.15	.26	.27*
23.	The main route of exposure to mercury is through cereal intake.	.84	.37	.42*
24.	Exposure to lead through diet occurs mainly through fish intake.	.36	.53	.40*
25.	Food colourings and preservatives are associated with central nervous system problems.	.98	.03	.08
26.	The relationships between environmental exposure and children's health consequences are complex.	.83	-.08	.08
27.	Genetically modified foods cause fewer allergic reactions in children.	.98	.05	.08
28.	Schools and kindergartens should be places free of environmental risks.	.98	.05	.26*
29.	Children are exposed to higher concentrations of air pollutants at home than outdoors.	.73	.45	.41*
30.	Parks and gardens are the areas with the least environmental pollutants where children can play.	.66	.58	.47*

Note. dI = difficulty index; DI = discrimination index; I-T = item-total correlation.
*$p < .05$

ChEHK-Q: INTER-ITEM CORRELATION IN THE PILOT TEST

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1	-.05	.07	.00	-.08	-.05	.07	.00	-.08	-.05	.07	.00	-.08	.08	-.05	.07	.00	-.08	-.05	.07	.00	-.08	-.05	.07	.00	-.08	-.05	.07	.00	-.08
2	-.07	1	-.03	-.02	-.02	-.02	-.01	.05	-.01	-.04	-.03	-.04	-.05	-.05	-.02	-.02	.30*	-.07	-.02	.04	-.13	-.11	-.05	.09	-.02	-.05	-.13	-.02	-.07	-.08
3	-.02	-.03	1	-.04	-.04	-.04	-.03	.12	-.02	-.02	-.07	.00	.20*	.04	-.04	.20*	-.05	.04	-.04	.10	-.12	.12	.15	.00	-.04	.08	-.12	-.04	.23*	.12
4	.04	-.02	-.04	1	-.02	-.02	-.02	-.20*	-.01	-.05	.17*	-.05	.18*	-.07	.32*	-.03	.50*	-.03	-.02	-.24*	-.14	.06	-.06	-.09	-.02	.06	-.14	-.02	-.09	.00
5	.00	-.02	-.04	-.02	1	-.02	-.02	-.07	-.01	-.05	-.04	.12	-.07	-.05	-.02	-.03	-.03	.08	.32*	-.10	.03	.06	-.06	.01	-.02	.06	.03	-.02	-.09	.00
6	-.11	-.02	-.04	-.02	-.02	1	-.02	-.07	-.01	-.05	-.04	-.05	-.07	.03	-.02	-.03	-.03	-.03	-.02	-.10	.10	-.34*	-.06	-.19*	-.02	-.06	.10	-.02	.02	-.10
7	-.05	-.01	-.03	-.02	-.02	-.02	1	-.11	-.01	.14	.22*	-.04	-.05	.05	-.02	-.02	-.02	-.07	-.02	-.14	-.14	.05	-.05	-.03	-.02	-.05	-.14	-.02	-.07	.04
8	.09	.05	.12	-.20*	-.07	-.07	-.11	1	.03	-.02	.03	-.18*	.10	-.13	-.07	.09	-.13	.23*	-.07	.19*	-.04	.03	.09	.14	.06	-.10	-.04	-.07	.18*	.07
9	-.02	-.01	-.02	-.01	-.01	-.01	-.01	.03	1	.22*	-.02	-.03	-.04	-.05	-.01	-.02	-.02	.05	-.01	.03	-.15	.03	-.04	-.11	-.01	-.04	-.15	-.01	-.05	.11
10	-.05	-.04	-.02	-.05	-.05	-.05	.14	-.02	.22*	1	.08	-.05	.04	-.06	-.05	.03	.05	-.13	-.05	-.06	.05	-.02	.00	-.02	.10	-.06	.05	.10	.00	.04
11	-.07	-.03	-.07	.17*	-.04	-.04	.22*	.03	-.02	.08	1	.02	-.05	.08	.17*	-.05	.42*	-.12	-.04	-.17*	-.13	.03	-.11	.01	-.04	-.04	-.13	-.04	-.15	.00
12	-.02	-.04	.00	-.05	.12	-.05	-.04	-.18*	-.03	-.05	.02	1	-.09	-.05	.28*	.05	-.06	-.14	.28*	.05	-.12	.13	-.02	.05	-.05	.22*	-.12	.12	.16*	.01
13	.04	-.05	.20*	.18*	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	1	.04	.06	.34*	.10	.03	.06	.02	-.14	-.04	.20*	.11	.06	.10	-.14	.06	.05	.09
14	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07	-.07	-.05	.10	-.04	1	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09
15	-.11	-.02	-.04	.32*	-.02	-.02	-.02	-.07	-.01	-.05	.17*	.28*	.06	.08	1	.21*	.24*	-.14	.32*	-.10	.05	.06	.07	.01	-.02	.06	.05	.32*	.02	.18*
16	-.05	-.02	.20*	-.03	-.03	-.03	-.02	.09	-.02	.03	-.05	.05	.34*	-.05	.21*	1	-.04	-.04	.21*	.07	-.13	.09	.00	.08	.21*	.00	-.13	.21*	.10	.00
17	.09	.30*	-.05	.50*	-.03	-.03	-.02	-.13	-.02	.05	.42*	-.06	.10	.04	.24*	-.04	1	-.15	-.03	-.16*	-.12	-.03	-.08	-.02	-.03	-.08	-.12	-.03	-.11	-.05
18	-.02	-.07	.04	-.03	.08	-.03	-.07	.23*	.05	-.13	-.12	-.14	.03	-.07	-.14	-.04	-.15	1	-.03	-.06	-.14	.06	.13	.12	-.03	-.03	-.14	-.14	-.06	.15
19	-.05	-.02	-.04	-.02	.32*	-.02	-.02	-.07	-.01	-.05	-.04	.28*	.06	-.05	.32*	.21*	-.03	-.03	1	-.10	.03	.06	-.06	-.09	-.02	.19*	.03	.32*	.02	.20*
20	-.07	.04	.10	-.24*	-.10	-.10	-.14	.19*	.03	-.06	-.17*	.05	.02	.03	-.10	.07	-.16*	-.06	-.10	1	.10	.02	.16*	-.02	.05	-.05	.10	-.10	.09	.01
21	-.02	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07	-.07	-.05	1	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07
22	.04	-.11	.12	.06	.06	-.34*	.05	.03	.03	-.02	.03	.13	-.04	.08	.06	.09	-.03	.06	.06	.02	.05	1	-.11	-.05	.06	-.05	.05	.06	.18*	.07
23	.00	-.05	.15	-.06	-.06	-.06	-.05	.09	-.04	.00	-.11	-.02	.20*	-.05	.07	.00	-.08	.13	-.06	.16*	-.13	-.11	1	.22*	-.06	-.01	-.13	.07	.20*	.13
24	-.11	.09	.00	-.09	.01	-.19*	-.03	.14	-.11	-.02	.01	.05	.11	.04	.01	.08	-.02	.12	-.09	-.02	-.12	-.05	.22*	1	.01	.01	-.12	.11	.00	.11
25	-.05	-.02	-.04	-.02	-.02	-.02	-.02	.06	-.01	.10	-.04	-.05	.06	-.07	-.02	.21*	-.03	-.03	-.02	.05	-.14	.06	-.06	.01	1	-.06	-.14	-.02	-.09	.00
26	.09	-.05	.08	.06	.06	-.06	-.05	-.10	-.04	-.06	-.04	.22*	.10	-.05	.06	.00	-.08	-.03	.19*	-.05	.03	-.05	-.01	.01	-.06	1	.03	.19*	-.01	.08
27	-.02	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07	-.07	-.05	.10	-.04	.04	-.05	-.09	-.07	1	-.05	.07	.00
28	-.05	-.02	-.04	-.02	-.02	-.02	-.02	-.07	-.01	.10	-.04	.12	.06	.08	.32*	.21*	-.03	-.14	.32*	-.10	.05	.06	.07	.11	-.02	.19*	.05	1	.23*	.00
29	-.07	-.07	.23*	-.09	-.09	.02	-.07	.18*	-.05	.00	-.15	.16*	.05	-.05	.02	.10	-.11	-.06	.02	.09	-.13	.18*	.20*	.00	-.09	-.01	-.13	.23*	1	.05
30	-.02	-.08	.12	.00	.00	-.10	.04	.07	.11	.04	.00	.01	.09	.04	.20*	.00	-.05	.15	.20*	.01	-.12	.07	.13	.11	.00	.08	-.12	.00	.05	1

Note. *$p < .05$

12.13. APPENDIX 13

ChEHS-Q: ITEM-TOTAL CORRELATION IN THE PILOT TEST

	Item-Total Correlation
1	.634**
2	.644**
3	.608**
4	.656**
5	.680**
6	.704**
7	.673**

Note. **$p < .01$

ChEHS-Q: INTER-ITEM CORRELATION IN THE PILOT TEST

Item	1	2	3	4	5	6	7	8	9	10	11	12
1	1	.45**	.35**	.32**	.32**	.31**	.40**	.35**	.47**	.39**	.30**	.28**
2	.45**	1	.31**	.46**	.26**	.37**	.33**	.42**	.36**	.33**	.43**	.29**
3	.35**	.31**	1	.42**	.45**	.32**	.41**	.32**	.47**	.29**	.28**	.21**
4	.32**	.46**	.42**	1	.26**	.33**	.21**	.40**	.22**	.15**	.45**	.25**
5	.32**	.26**	.45**	.26**	1	.41**	.64**	.39**	.61**	.40**	.32**	.23**
6	.31**	.37**	.32**	.33**	.41**	1	.49**	.59**	.48**	.34**	.44**	.31**
7	.40**	.33**	.41**	.21**	.64**	.49**	1	.51**	.69**	.46**	.33**	.24**
8	.35**	.42**	.32**	.40**	.39**	.59**	.51**	1	.45**	.27**	.51**	.36**
9	.47**	.36**	.47**	.22**	.61**	.48**	.69**	.45**	1	.54**	.32**	.25**
10	.39**	.33**	.29**	.15**	.40**	.34**	.46**	.27**	.54**	1	.33**	.23**
11	.30**	.43**	.28**	.45**	.32**	.44**	.33**	.51**	.32**	.33**	1	.44**
12	.28**	.29**	.21**	.25**	.23**	.31**	.24**	.36**	.25**	.23**	.44**	1

Note. **$p < .01$

12.14. APPENDIX 14

ChEHK-Q: YEN´S Q_3 STATISTICAL

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	1	-.03	-.01	.00	-.03	.06	-.03	-.04	-.02	-.11	-.06	.04	-.05	.17	.03	-.01	.16	.01	.05	-.09	-.06	-.03	-.06	-.08	.00	-.03	-.05	-.13
2	-.03	1	.07	-.07	-.04	-.09	-.11	.19	-.14	.01	-.08	-.06	.09	.06	-.06	-.02	.03	.02	**-.21**	-.10	-.07	-.20	-.10	.01	-.01	.00	-.01	.18
3	-.01	.07	1	.01	.03	-.08	.08	-.01	.04	-.12	-.12	.02	.03	.01	.02	-.09	-.12	-.18	-.09	-.09	-.02	-.08	-.07	-.07	-.03	-.07	-.09	-.01
4	.00	-.07	.01	1	-.09	-.01	-.03	.02	-.05	-.06	.07	-.04	.02	-.16	.02	-.09	.03	-.16	-.03	-.03	-.13	-.03	.05	-.06	-.05	-.06	-.11	-.04
5	-.03	-.04	.03	-.09	1	**.26**	-.09	-.15	-.02	-.02	-.10	-.04	-.06	-.07	-.08	-.01	-.06	-.03	-.04	.00	.03	-.05	-.05	-.05	.04	.04	.02	-.14
6	.06	-.09	-.08	-.01	**.26**	1	-.10	-.02	-.03	.06	-.17	.03	-.11	-.03	-.02	-.13	.05	.09	-.01	-.07	-.08	-.03	-.02	.02	.00	-.04	-.05	-.04
7	-.03	-.11	.08	-.03	-.09	-.10	1	-.13	.00	-.14	.00	-.07	.02	-.01	-.05	**-.25**	-.06	-.13	.03	-.07	.01	.15	.00	**-.23**	.03	-.06	.08	.09
8	-.04	.19	-.01	.02	-.15	-.02	-.13	1	-.04	-.10	-.10	-.02	.00	-.12	.04	.00	-.05	-.01	-.08	-.10	-.12	-.14	-.08	.03	.04	-.03	-.08	.07
9	-.02	-.14	.04	-.05	-.02	-.03	.00	-.04	1	.03	-.09	-.05	-.12	-.16	-.02	-.04	-.03	-.07	-.06	-.01	-.02	-.03	-.01	-.08	-.05	-.01	-.04	-.07
10	-.11	.01	-.12	-.06	-.02	.06	-.14	-.10	.03	1	.01	-.13	.09	-.02	**-.21**	.06	.05	.11	-.17	.08	-.11	-.13	-.03	.13	-.08	-.17	-.06	-.17
11	-.06	-.08	-.12	.07	-.10	-.17	.00	-.10	-.09	.01	1	.00	.01	-.07	.01	.02	-.06	.00	-.06	.01	.02	-.02	.02	-.11	-.07	-.01	-.02	-.12
12	.04	-.06	.02	-.04	-.04	.03	-.07	-.02	-.05	-.13	.00	1	-.16	.04	.11	-.13	-.08	-.15	.11	-.14	-.03	.09	-.06	-.12	-.05	-.04	.00	-.03
13	-.05	.09	.03	.02	-.06	-.11	.02	.00	-.12	.09	.01	-.16	1	-.04	-.10	.08	.03	-.06	-.09	-.07	-.04	-.14	-.04	-.03	.07	-.13	-.16	-.15
14	.17	.06	.01	-.16	-.07	-.03	-.01	-.12	-.16	-.02	-.07	.04	-.04	1	.12	.05	-.07	.08	-.07	.03	-.06	-.04	-.16	.02	-.06	-.01	-.11	-.09
15	.03	-.06	.02	.02	-.08	-.02	-.05	.04	-.02	**-.21**	.01	.11	-.10	.12	1	-.10	-.10	**-.21**	.06	-.05	-.08	-.02	-.14	-.02	.08	-.07	-.06	-.13
16	-.01	-.02	-.09	-.09	-.01	-.13	**-.25**	.00	-.04	.06	.02	-.13	.08	.05	-.10	1	.06	.08	-.08	-.02	.00	**-.23**	-.11	.09	-.14	-.09	-.02	-.02
17	.16	.03	-.12	.03	-.06	.05	-.06	-.05	-.03	.05	-.06	-.08	.03	-.07	-.10	.06	1	.12	-.09	.01	-.15	-.20	-.12	.10	-.06	-.14	-.11	-.10
18	.01	.02	-.18	-.16	-.03	.09	-.13	-.01	-.07	.11	.00	-.15	-.06	.08	**-.21**	.08	.12	1	-.17	.00	.00	-.18	-.03	.06	-.05	-.10	-.06	.05
19	.05	**-.21**	-.09	-.03	-.04	-.01	.03	-.08	-.06	-.17	-.06	.11	-.09	-.07	.06	-.08	-.09	-.17	1	.00	.04	.14	.01	-.09	-.09	.05	-.06	-.04
20	-.09	-.10	-.09	-.03	.00	-.07	-.07	-.10	-.01	.08	.01	-.14	-.07	.03	-.05	-.02	.01	.00	.00	1	-.10	-.05	-.02	.00	-.12	-.04	-.17	.00
21	-.06	-.07	-.02	-.13	.03	-.08	.01	-.12	-.02	-.11	.02	-.03	-.04	-.06	-.08	.00	-.15	.00	.04	-.10	1	-.01	.11	-.05	-.12	.05	.07	.03
22	-.03	-.20	-.08	-.03	-.05	-.03	.15	-.14	-.03	-.13	-.02	.09	-.14	-.04	-.02	**-.23**	-.20	-.18	.14	-.05	-.01	1	**.23**	-.12	-.05	.10	.07	-.12
23	-.06	-.10	-.07	.05	-.05	-.02	.00	-.08	-.01	-.03	.02	-.06	-.04	-.16	-.14	-.11	-.12	-.03	.01	-.02	.11	**.23**	1	-.18	-.14	.07	.03	-.09
24	-.08	.01	-.07	-.06	-.05	.02	**-.23**	.03	-.08	.13	-.11	-.12	-.03	.02	-.02	.09	.10	.06	-.09	.00	-.05	-.12	-.18	1	.00	-.09	-.12	-.07
25	.00	-.01	-.03	-.05	.04	.00	.03	.04	-.05	-.08	-.07	-.05	.07	-.06	.08	-.14	-.06	-.05	-.09	-.12	-.12	-.05	-.14	.00	1	.06	-.07	-.07
26	-.03	.00	-.07	-.06	.04	-.04	-.06	-.03	-.01	-.17	-.01	-.04	-.13	-.01	-.07	-.09	-.14	-.10	.05	-.04	.05	.10	.07	-.09	.06	1	.02	.10
27	-.05	-.01	-.09	-.11	.02	-.05	.08	-.08	-.04	-.06	-.02	.00	-.16	-.11	-.06	-.02	-.11	-.06	-.06	-.17	.07	.07	.03	-.12	-.07	.02	1	.02
28	-.13	.18	-.01	-.04	-.14	-.04	.09	.07	-.07	-.17	-.12	-.03	-.15	-.09	-.13	-.02	-.10	.05	-.04	.00	.03	-.12	-.09	-.07	-.07	.10	.02	1

Note. Values exceeding the limits set for Yen´s Q_3 (±0.30) are in boldface.

12.15. APPENDIX 15

ChEHS-Q: YEN´S Q_3 STATISTICAL

Item	1	2	3	4	5	6	7	8	9	10	11	12
1	1	-.02	.01	-.09	.01	-.16	-.10	**-.21**	-.13	-.11	-.15	-.11
2	-.02	1	**-.22**	.17	**-.27**	-.10	**-.26**	-.06	-.15	**-.28**	.03	.05
3	.01	**-.22**	1	.11	-.04	**-.23**	.03	**-.28**	-.10	.06	**-.28**	-.06
4	-.09	.17	.11	1	**-.24**	-.13	-.15	-.05	**-.38**	**-.26**	.13	-.14
5	.01	**-.27**	-.04	**-.24**	1	-.07	**.24**	**-.22**	.12	-.01	**-.27**	-.20
6	-.16	-.10	**-.23**	-.13	-.07	1	-.20	.20	-.14	-.19	.13	-.09
7	-.10	**-.26**	.03	-.15	**.24**	-.20	1	-.16	.11	.07	**-.24**	**-.30**
8	**-.21**	-.06	**-.28**	-.05	**-.22**	.20	-.16	1	-.10	-.17	.17	-.10
9	-.13	-.15	-.10	**-.38**	.12	-.14	.11	-.10	1	**.26**	**-.24**	-.12
10	-.11	**-.28**	.06	**-.26**	-.01	-.19	.07	-.17	.26	1	-.18	-.05
11	-.15	.03	**-.28**	.13	**-.27**	.13	**-.24**	.17	**-.24**	-.18	1	-.06
12	-.11	.05	-.06	-.14	-.20	-.09	**-.30**	-.10	-.12	-.05	-.06	1

Note. Values exceeding the limits set for Yen´s Q_3 (±0.30) are in boldface.

12.16. APPENDIX 16

ChEHK-Q (versión en español)

Cuestionario de Conocimientos en Salud Medioambiental Infantil

Puede utilizar este cuestionario con fines de investigación siempre que cite la fuente original. Si modifica el cuestionario por favor, informe a los autores, mediante un mensaje de correo electrónico a: cagarcia@ujaen.es

Citar como: Álvarez-García, C., Álvarez-Nieto, C., Pancorbo-Hidalgo, P. L., Sanz-Martos, S., & López-Medina, I. M. (2018). Student nurses' knowledge and skills of children's environmental health: Instrument development and psychometric analysis using item response theory. *Nurse Education Today, 69*, 113-119. https://doi.org/10.1016/j.nedt.2018.07.008

Este cuestionario permite medir conocimientos sobre los temas relacionadas con la sostenibilidad y el cambio climático y sus efectos en la prestación de servicios de salud. Es aplicable a estudiantes de Enfermería.

Instrucciones de puntuación

Para calcular la puntuación global del cuestionario se suma 1 punto por cada ítem con respuesta correcta. En la siguiente tabla se muestran las respuestas correctas:

	Verdadero	Falso
1	x	
2		x
3	x	
4		x
5		x
6	x	
7		x
8	x	
9	x	
10		x
11	x	
12	x	
13		x
14	x	
15	x	
16	x	
17		x
18	x	
19		x
20		x
21		x
22	x	
23		x
24		x
25		x
26		x

Los ítems cuya respuesta es “No se” se puntúan con 0 puntos para el cálculo de la puntuación global. Estos ítems se pueden tener en cuenta para identificar áreas de desconocimiento.

La puntuación máxima que se puede obtener en el cuestionario es 26 puntos (Índice de Conocimientos 100%). A partir de la puntuación se pueden calcular los siguientes índices:

- Índice de Conocimientos = Puntuación obtenida / 26 X 100
- Índice de Desconocimiento = Número de respuestas No sé / 26 X 100

Para categorizar el nivel de conocimientos de los estudiantes de enfermería siguiendo el Índice de Conocimientos se proponen los siguientes rangos:

→ > 90% = conocimientos excelentes
→ 89% - 80% = conocimientos muy buenos
→ 79% - 60% = conocimientos buenos
→ 59% - 40% = conocimientos insuficientes
→ < 39% = conocimientos pobres

ChEHK-Q (versión en español)

La sostenibilidad en la asistencia sanitaria significa diseñar y ofrecer una asistencia sanitaria que utilice los recursos de manera que no perjudique la salud y el bienestar futuros.

A continuación, hay una serie de afirmaciones sobre la salud medioambiental en la infancia. Por favor, lee cuidadosamente cada afirmación, y marca la casilla de Verdadero o Falso según consideres, o No sé si desconoces la respuesta.

	Verdadero	Falso	No sé
1. La población pediátrica es más susceptible a las amenazas medioambientales debido a su inmadurez biológica.	☐	☐	☐
2. El mayor consumo energético y metabólico de la población pediátrica protege a la infancia de los peligros medioambientales.	☐	☐	☐
3. La mayor tasa de crecimiento celular en la edad pediátrica incrementa el riesgo de efectos para la salud derivados de factores medioambientales.	☐	☐	☐
4. Los factores medioambientales no influyen en la secreción hormonal durante la pubertad.	☐	☐	☐
5. El óxido de nitrógeno procedente de combustibles fósiles en el hogar y humo de tabaco producen enrojecimiento y quemaduras en la piel.	☐	☐	☐
6. Las partículas procedentes de animales agravan las crisis asmáticas.	☐	☐	☐
7. El aumento de la humedad ambiental del hogar mejora las enfermedades respiratorias en los niños y las niñas.	☐	☐	☐
8. El tabaquismo pasivo está asociado al desarrollo de leucemias agudas en la infancia.	☐	☐	☐
9. Las tasas de incidencia de leucemia infantil son mayores en las zonas con mayor exposición a radón.	☐	☐	☐
10. La sobreexposición a las radiaciones ultravioletas solares puede dañar más intensamente la piel de los adultos que la de los niños y las niñas.	☐	☐	☐
11. Durante la infancia se absorbe más de la mitad de la radiación ultravioleta solar esperada a lo largo de toda la vida.	☐	☐	☐
12. El plomo se acumula en el organismo afectando al sistema nervioso.	☐	☐	☐

	Verdadero	Falso	No sé
13. La exposición crónica al mercurio a través de la dieta (pescados y mariscos) es menos tóxica para el sistema nervioso central de los niños y las niñas que para el de los adultos.	☐	☐	☐
14. La exposición a plaguicidas aumenta el riesgo de desarrollar problemas de déficit de atención en escolares.	☐	☐	☐
15. Los hijos e hijas de madres fumadoras durante el embarazo tienen riesgo de presentar menor capacidad intelectual.	☐	☐	☐
16. La exposición a solventes orgánicos durante el desarrollo fetal puede provocar trastornos del aprendizaje en un niño o una niña.	☐	☐	☐
17. El agua que contiene nitratos puede producir intoxicación sólo durante la infancia.	☐	☐	☐
18. La cloración del agua forma subproductos del proceso de desinfección que han sido clasificados como cancerígenos.	☐	☐	☐
19. La mayor fuente de exposición infantil a pesticidas es a través del aire ambiental.	☐	☐	☐
20. La principal vía de exposición al mercurio es a través de la ingesta de cereales.	☐	☐	☐
21. La exposición al plomo a través de la dieta ocurre principalmente con la ingesta de pescado.	☐	☐	☐
22. Los colorantes y los conservantes alimentarios se asocian a problemas del sistema nervioso central.	☐	☐	☐
23. Los alimentos modificados genéticamente producen menos reacciones alérgicas en niños o niñas.	☐	☐	☐
24. Las escuelas y guarderías son lugares libres de riesgos medioambientales.	☐	☐	☐
25. Los niños y niñas están expuestos a mayores concentraciones de contaminantes atmosféricos en casa que en el exterior.	☐	☐	☐
26. Los parques y los jardines son las áreas más libres de contaminantes ambientales en las que pueden jugar niños y niñas.	☐	☐	☐

12.17. APPENDIX 17

ChEHS-Q (versión en español)

Cuestionario de Habilidades en Salud Medioambiental Infantil

Puede utilizar este cuestionario con fines de investigación siempre que cite la fuente original. Si modifica el cuestionario por favor, informe a los autores, mediante un mensaje de correo electrónico a: cagarcia@ujaen.es

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Este cuestionario permite medir habilidad percibida para tratar temas relacionadas con la sostenibilidad y el cambio climático en la prestación de servicios de salud. Es aplicable a estudiantes de Enfermería.

Instrucciones de puntuación

Para calcular la puntuación global se suman las puntuaciones que cada estudiante ha asignado a cada ítem.

La puntuación máxima que se puede obtener en el cuestionario es 60 puntos (índice de habilidad 100%). A partir de la puntuación se puede calcular el siguiente índice:

- Índice de Habilidad = Puntuación obtenida / 60 X 100

Para categorizar el nivel de habilidad percibida por los estudiantes de enfermería se proponen los siguientes rangos:

→ > 90% = habilidades excelentes
→ 89% - 80% = habilidades muy buenas
→ 79% - 70% = habilidades buenas
→ 69% - 50% = habilidades insuficientes
→ < 49% = habilidades pobres

ChEHS-Q (versión en español)

La sostenibilidad en la asistencia sanitaria significa diseñar y ofrecer una asistencia sanitaria que utilice los recursos de manera que no perjudique la salud y el bienestar futuros. A continuación, hay una serie de afirmaciones sobre habilidades en salud medioambiental infantil. Por favor, señala la respuesta de 1 a 5 según consideres que se corresponda contigo cada afirmación.

1. Soy capaz de valorar los principales riesgos medioambientales a los que está expuesto un niño o una niña.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

2. NO soy capaz de identificar los riesgos medioambientales que pueden producir enfermedades respiratorias en un niño o una niña.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

3. Soy capaz de reconocer los riesgos medioambientales que pueden producir enfermedades neoplásicas en un niño o una niña.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

4. NO soy capaz de identificar los riesgos medioambientales que pueden producir enfermedades neurológicas en un niño o una niña.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

5. Soy capaz de realizar educación sanitaria a padres y madres sobre los principales contaminantes presentes en los alimentos de su hijo o hija.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

6. NO soy capaz identificar los riesgos medioambientales existentes en parques infantiles.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

7. Soy capaz de realizar educación sanitaria a padres y madres sobre las actuaciones para minimizar los riesgos medioambientales a los que está expuesto un niño o una niña cuando juega al aire libre.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

8. NO soy capaz de identificar los riesgos medioambientales existentes en la casa de un niño o una niña.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

9. Soy capaz de realizar educación sanitaria a padres y madres sobre los riesgos medioambientales existentes en el hogar.

   Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

10. Soy capaz de identificar los riesgos medioambientales existentes en el colegio de un niño o una niña.

    Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

11. NO soy capaz de identificar las actuaciones necesarias para combatir los riesgos medioambientales existentes en el colegio de un niño o una niña.

    Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

12. NO me siento capaz de desarrollar mi trabajo como enfermera en una Unidad de Salud Medioambiental Pediátrica.

    Totalmente en desacuerdo 1 2 3 4 5 Totalmente de acuerdo

12.18. APPENDIX 18

CHEHK-Q: TRANSLATION MATRIX

1. The paediatric population is more susceptible to environmental threats due to their biological immaturity. **Spanish item:** La población pediátrica es más susceptible a las amenazas medioambientales debido a su inmadurez biológica. **Back-translation 1:** La población pediátrica es más susceptible a las amenazas medioambientales debido a su inmadurez biológica. **Back-translation 2:** La población pediátrica es más susceptible a los riesgos ambientales debido a su inmadurez bilógica.
2. The increased energy and metabolic consumption of the paediatric population protects children from environmental hazards. **Spanish item:** El mayor consumo energético y metabólico de la población pediátrica protege a la infancia de los peligros medioambientales. **Back-translation 1:** El aumento del consumo energético y metabólico de la población pediátrica protege a los/las niños/as de peligros medioambientales. **Back-translation 2:** El mayor gasto metabólico y de energía de la población pediátrica protege a los niños de los peligros ambientales.
3. The higher rate of cell growth during the paediatric age increases the risk of health effects caused by environmental factors. **Spanish item:** La mayor tasa de crecimiento celular en la edad pediátrica incrementa el riesgo de efectos para la salud derivados de factores medioambientales. **Back-translation 1:** El mayor índice de crecimiento celular durante la edad pediátrica incrementa el riesgo de efectos en la salud causados por factores medioambientales. **Back-translation 2:** La mayor tasa de crecimiento celular durante la edad pediátrica aumenta el riesgo de efectos sobre la salud causados por factores ambientales.
4. Environmental factors do not influence hormonal secretion during puberty. **Spanish item:** Los factores medioambientales no influyen en la secreción hormonal durante la pubertad. **Back-translation 1:** Los factores medioambientales no influyen en la secreción de hormonas durante la pubertad. **Back-translation 2:** Los factores ambientales no influyen en la secreción hormonal durante la pubertad.
5. Nitrogen oxide from fossil fuels in the home and tobacco smoke causes redness and burns on the skin. **Spanish item:** El óxido de nitrógeno procedente de combustibles fósiles en el hogar y humo de tabaco producen enrojecimiento y quemaduras en la piel. **Back-translation 1:** El óxido de nitrógeno procedente de combustibles fósiles domésticos y el humo del tabaco pueden causar enrojecimiento y quemaduras en la piel. **Back-translation 2:** El óxido de nitrógeno procedente de combustibles fósiles en el hogar y el humo del tabaco pueden provocar rojeces y quemaduras en la piel.
6. Particles from animals exacerbate asthma crisis. **Spanish item:** Las partículas procedentes de animales agravan las crisis asmáticas. **Back-translation 1:** Las partículas procedentes de animales empeoran la crisis asmática. **Back-translation 2:** Partículas procedentes de animales pueden exacerbar las crisis de asma.
7. Increased humidity at home improves respiratory diseases in children. **Spanish item:** El aumento de la humedad ambiental del hogar mejora las enfermedades respiratorias en los niños y las niñas. **Back-translation 1:** El incremento de la humedad interior mejora las enfermedades respiratorias infantiles. **Back-translation 2:** Una alta humedad en espacios interiores mejora las enfermedades respiratorias en los niños.

8. Passive smoking is associated with the development of acute leukemias in children.

Spanish item: El tabaquismo pasivo está asociado al desarrollo de leucemias agudas en la infancia.
Back-translation 1: El/La fumador/a pasivo/a está asociado/a al desarrollo de leucemia infantil aguda.
Back-translation 2: Fumar pasivamente se ha asociado al desarrollo de leucemia aguda en niños.

9. Childhood leukemia incidence rates are higher in the areas most exposed to radon.

Spanish item: Las tasas de incidencia de leucemia infantil son mayores en las zonas con mayor exposición a radón.
Back-translation 1: Los índices de incidencia de leucemia infantil son más altos en las zonas de mayor exposición al radón.
Back-translation 2: Las tasas de incidencia de leucemia infantil son mayores en las áreas más expuestas a radón.

10. Overexposure to solar ultraviolet radiations can damage the skin of adults more severely than that of children.

Spanish item: La sobreexposición a las radiaciones ultravioletas solares puede dañar más intensamente la piel de los adultos que la de los niños y las niñas.
Back-translation 1: La sobreexposición a la radiación solar ultravioleta puede dañar la piel de los/las adultos/as de forma más severa que la de los/las niños/as.
Back-translation 2: La sobreexposición a radiación solar ultravioleta puede dañar la piel de los adultos de forma más grave que en niños.

11. During childhood more than half of the expected lifetime solar ultraviolet radiation is absorbed.

Spanish item: Durante la infancia se absorbe más de la mitad de la radiación ultravioleta solar esperada a lo largo de toda la vida.
Back-translation 1: Durante la niñez se absorbe más de la mitad de la radiación ultravioleta estimada para toda la vida.
Back-translation 2: Durante la infancia, se absorbe más de la mitad de la radiación solar ultravioleta de la esperada a lo largo de la vida.

12. Lead accumulates in the body affecting the nervous system.

Spanish item: El plomo se acumula en el organismo afectando al sistema nervioso.
Back-translation 1: El plomo se acumula en el cuerpo afectando al sistema nervioso.
Back-translation 2: El plomo se acumula en el cuerpo, afectando al sistema nervioso.

13. Chronic dietary exposure to mercury (fish and shellfish) is less toxic to children's central nervous system than to adults.

Spanish item: La exposición crónica al mercurio a través de la dieta (pescados y mariscos) es menos tóxica para el sistema nervioso central de los niños y las niñas que para el de los adultos.
Back-translation 1: La exposición dietética crónica al mercurio (pescado y marisco) es menos tóxica para el sistema nervioso central de los/niños/as que para el de los/las adultos/as.
Back-translation 2: La exposición crónica a mercurio en la dieta (pescados y marisco) es menos tóxica para el sistema nervioso central de los niños que para el de los adultos.

14. Exposure to pesticides increases the risk of developing attention deficit problems in school-aged children.

Spanish item: La exposición a plaguicidas aumenta el riesgo de desarrollar problemas de déficit de atención en escolares.
Back-translation 1: La exposición a pesticidas incrementa el riesgo de desarrollar problemas de déficit de atención en niños/as en edad escolar.
Back-translation 2: La exposición a los pesticidas aumenta el riesgo de desarrollar problemas de déficit de atención en los niños en edad escolar.

15. Children born to smoking mothers during pregnancy are at risk of lower intellectual capacity.

Spanish item: Los hijos e hijas de madres fumadoras durante el embarazo tienen riesgo de presentar menor capacidad intelectual.
Back-translation 1: Los/Las niños/as de madres fumadoras durante el embarazo están en riesgo de capacidad intelectual más baja.
Back-translation 2: Los hijos de madres fumadoras durante el embarazo tienen riesgo de una menor capacidad intelectual.

16. Exposure to organic solvents during fetal development can cause learning disabilities in children.

Spanish item: La exposición a solventes orgánicos durante el desarrollo fetal puede provocar trastornos del aprendizaje en un niño o una niña.
Back-translation 1: La exposición a disolventes orgánicos durante el desarrollo fetal puede causar en los/las niños/as discapacidades de aprendizaje.
Back-translation 2: La exposición a disolventes orgánicos durante el desarrollo fetal puede provocar déficits en el aprendizaje en niños.

17. Water containing nitrates can only cause intoxication during childhood.

Spanish item: El agua que contiene nitratos puede producir intoxicación sólo durante la infancia.
Back-translation 1: El agua con nitratos solo puede causar envenenamiento durante la niñez.
Back-translation 2: El agua con nitratos sólo puede causar envenenamiento durante la infancia.

18. Chlorination of water forms sub-products from the disinfection process that have been classified as carcinogenic.

Spanish item: La cloración del agua forma subproductos del proceso de desinfección que han sido clasificados como cancerígenos.
Back-translation 1: La cloración del agua produce subproductos procedentes del proceso de desinfección que han sido clasificados como cancerígenos.
Back-translation 2: La cloración del agua forma subproductos del proceso de desinfección que han sido clasificados como carcinógenos.

19. The major source of childhood exposure to pesticides is through ambient air.

Spanish item: La mayor fuente de exposición infantil a pesticidas es a través del aire ambiental.
Back-translation 1: La mayor fuente de exposición infantil a los pesticidas es a través del aire ambiente.
Back-translation 2: La mayor fuente de exposición infantil a pesticidas es a través del aire ambiental.

20. The main route of exposure to mercury is through cereal intake.

Spanish item: La principal vía de exposición al mercurio es a través de la ingesta de cereales.
Back-translation 1: La principal ruta de exposición al mercurio es a través de la ingesta de cereales.
Back-translation 2: La ruta principal de exposición al mercurio es a través de la ingesta de cereales.

21. Exposure to lead through diet occurs mainly through fish intake.

Spanish item: La exposición al plomo a través de la dieta ocurre principalmente con la ingesta de pescado.
Back-translation 1: La exposición al plomo a través de la dieta ocurre principalmente a través de la ingesta de pescado.
Back-translation 2: La exposición al plomo a través de la dieta ocurre principalmente a través del pescado.

22. Food colourings and preservatives are associated with central nervous system problems.

Spanish item: Los colorantes y los conservantes alimentarios se asocian a problemas del sistema nervioso central.
Back-translation 1: Los colorantes y conservantes alimenticios están asociados a problemas del sistema nervioso central.
Back-translation 2: Los colorantes y conservantes alimentarios se asocian a problemas del sistema nervioso central.

23. Genetically modified foods cause fewer allergic reactions in children.

Spanish item: Los alimentos modificados genéticamente producen menos reacciones alérgicas en niños o niñas.
Back-translation 1: Los alimentos genéticamente modificados causan menos reacciones alérgicas en los/las niños/as.
Back-translation 2: Los alimentos modificados genéticamente causan menos reacciones alérgicas en niños.

24. Schools and nurseries are environmentally safe places.

Spanish item: Las escuelas y guarderías son lugares libres de riesgos medioambientales.
Back-translation 1: Las escuelas y las guarderías son lugares seguros desde un punto de vista medioambiental.
Back-translation 2: Los colegios y guarderías son sitios ambientalmente seguros.

25. Children are exposed to higher concentrations of air pollutants at home than outdoors. **Spanish item:** Los niños y niñas están expuestos a mayores concentraciones de contaminantes atmosféricos en casa que en el exterior. **Back-translation 1:** Los/Las niños/as están expuestos en su casa a mayores concentraciones de contaminantes aéreos que fuera de ella. **Back-translation 2:** Los niños están expuestos a concentraciones más altas de sustancias contaminantes en el aire dentro de casa que al aire libre.
26. Parks and gardens are the areas with the least environmental pollutants where children can play. **Spanish item:** Los parques y los jardines son las áreas más libres de contaminantes ambientales en las que pueden jugar niños y niñas. **Back-translation 1:** Los parques y los jardines son las áreas con menos contaminantes medioambientales donde los/las niños/as pueden jugar. **Back-translation 2:** Los parques y jardines son las áreas con menor cantidad de contaminantes ambientales donde los niños pueden jugar.

12.19. APPENDIX 19

CHEHS-Q: TRANSLATION MATRIX

1. I am able to assess the main environmental risks to which a child is exposed. **Spanish item:** Soy capaz de valorar los principales riesgos medioambientales a los que está expuesto un niño o una niña. **Back-translation 1:** Soy capaz de evaluar los principales riesgos medioambientales a los que un/a niño/a está expuesto/a. **Back-translation 2:** Soy capaz de valorar los principales riesgos ambientales a los que un niño está expuesto.
2. I am NOT able to identify the environmental risks that can cause respiratory diseases in a child. **Spanish item:** NO soy capaz de identificar los riesgos medioambientales que pueden producir enfermedades respiratorias en un niño o una niña. **Back-translation 1:** NO soy capaz de identificar los riesgos medioambientales que las enfermedades respiratorias pueden causar en un/a niño/a. **Back-translation 2:** NO soy capaz de identificar los riesgos ambientales que las enfermedades respiratorias pueden provocar en un niño
3. I am able to identify the environmental risks that can cause neoplastic diseases in a child. **Spanish item:** Soy capaz de reconocer los riesgos medioambientales que pueden producir enfermedades neoplásicas en un niño o una niña. **Back-translation 1:** Soy capaz de identificar los riesgos medioambientales que las enfermedades neoplásicas pueden causar en un/a niño/a. **Back-translation 2:** Soy capaz de identificar los riesgos ambientales que las enfermedades neoplásicas pueden producir en un niño.
4. I am NOT able to identify the environmental risks that can cause neurological disorders in a child. **Spanish item:** NO soy capaz de identificar los riesgos medioambientales que pueden producir enfermedades neurológicas en un niño o una niña. **Back-translation 1:** NO soy capaz de identificar los riesgos medioambientales que pueden causar desórdenes neurológicos en un/a niño/a. **Back-translation 2:** No soy capaz de identificar los riesgos ambientales que pueden causar alteraciones neurológicas en un niño.
5. I am able to provide health education to parents about the main contaminants in their child's food. **Spanish item:** Soy capaz de realizar educación sanitaria a padres y madres sobre los principales contaminantes presentes en los alimentos de su hijo o hija. **Back-translation 1:** Soy capaz de proporcionar a los/las padres/madres educación en salud sobre los principales contaminantes en la comida de sus niños/as. **Back-translation 2:** Soy capaz de proporcionar formación para la salud a los padres sobre los principales contaminantes en la comida de sus hijos.
6. I am NOT able to identify the environmental risks in playgrounds. **Spanish item:** NO soy capaz identificar los riesgos medioambientales existentes en parques infantiles. **Back-translation 1:** NO soy capaz de identificar riesgos medioambientales en los/las patios de recreo / zonas de juego infantil. **Back-translation 2:** NO soy capaz de identificar los riesgos ambientales de los parques infantiles.

7. I am able to provide health education to parents about actions to minimize environmental risks to which a child is exposed when playing outdoors. **Spanish item:** Soy capaz de realizar educación sanitaria a padres y madres sobre las actuaciones para minimizar los riesgos medioambientales a los que está expuesto un niño o una niña cuando juega al aire libre. **Back-translation 1:** Soy capaz de proporcionar a los/las padres/madres educación en salud sobre acciones que minimizan los riesgos medioambientales a los que un/a niño/a se expone cuando juega fuera. **Back-translation 2:** Soy capaz de proporcionar formación para la salud a los padres sobre las acciones a tomar para minimizar los riesgos ambientales a los que un niño está expuesto cuando juega al aire libre.
8. I am NOT able to identify the environmental risks in a child's home. **Spanish item:** NO soy capaz de identificar los riesgos medioambientales existentes en la casa de un niño o una niña. **Back-translation 1:** NO soy capaz de identificar los riesgos medioambientales en el hogar de un/a niño/a. **Back-translation 2:** NO soy capaz de identificar los riesgos ambientales en la casa de un niño.
9. I am able to provide health promotion to parents about environmental risks at home. **Spanish item:** Soy capaz de realizar educación sanitaria a padres y madres sobre los riesgos medioambientales existentes en el hogar. **Back-translation 1:** Soy capaz de proporcionar a los/las padres/madres promoción en salud sobre los riesgos medioambientales en el hogar. **Back-translation 2:** Soy capaz de proporcionar difusión de la salud a los padres sobre riesgos ambientales en el hogar.
10. I am able to identify the environmental risks in a child's school. **Spanish item:** Soy capaz de identificar los riesgos medioambientales existentes en el colegio de un niño o una niña. **Back-translation 1:** Soy capaz de identificar los riesgos medioambientales los centros de educación infantil. **Back-translation 2:** Soy capaz de identificar los riesgos ambientales en el colegio de un niño.
11. I am NOT able to identify the actions needed to combat environmental risks in a child's school. **Spanish item:** NO soy capaz de identificar las actuaciones necesarias para combatir los riesgos medioambientales existentes en el colegio de un niño o una niña. **Back-translation 1:** NO soy capaz de identificar las acciones necesarias para combatir los riesgos medioambientales en los centros de educación infantil. **Back-translation 2:** NO soy capaz de identificar las acciones necesarias para combatir los riesgos ambientales en el colegio de un niño
12. I do NOT feel able to do my job as a nurse in a Pediatric Environmental Health Specialty Unit. **Spanish item:** NO me siento capaz de desarrollar mi trabajo como enfermera en una Unidad de Salud Medioambiental Pediátrica. **Back-translation 1:** NO me siento capaz de realizar mi trabajo como enfermero/a en una Unidad Especializada de Salud Medioambiental Pediátrica. **Back-translation 2:** No me siento capaz de hacer mi trabajo como enfermera en una Unidades Especializadas en Salud Ambiental Pediátrica.

12.20. APPENDIX 20

ChEHK-Q (English version)

Children´s Environmental Health Knowledge Questionnaire

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This questionnaire measures the overall knowledge on sustainability and climate change issues and their effects on healthcare delivery. It could be used for nursing students.

Scoring instructions

To calculate the overall knowledge score, 1 point is added for each item with a correct answer. The following table shows the correct answer:

	True	False
1	x	
2		x
3	x	
4		x
5		x
6	x	
7		x
8	x	
9	x	
10		x
11	x	
12	x	
13		x
14	x	
15	x	
16	x	
17		x
18	x	
19		x
20		x
21		x
22	x	
23		x
24		x
25		x
26		x

Items answered with “I don’t know” are scored with 0 points. These items can be taken into account to identify areas of ignorance.

The maximum score is 26 points (Knowledge index 100%). Several indices can be calculated from the overall score:

- Knowledge Index: Overall score / 26 X 100
- Ignorance Index: Number of I don’t know answers / 26 X 100

To categorize the knowledge level of nursing students according to the Knowledge Index, the following ranges are proposed:

→ > 90% = excellent knowledge
→ 89% - 80% = very good knowledge
→ 79% - 60% = good knowledge
→ 59% - 40% = insufficient knowledge
→ < 39% = poor knowledge

ChEHK-Q (English version)

Sustainability in healthcare means designing and delivering healthcare that uses resources in ways that don't prejudice future health and wellbeing.

Next, there are a series of statements about children´s environmental health. Please, read each statement carefully and tick one box, "Yes" or "No", to indicate whether you consider it correct or not according to current clinical practice guidelines. If you don´t know please, tick "I don´t know".

	True	False	I don´t know
1. The paediatric population is more susceptible to environmental threats due to their biological immaturity.	☐	☐	☐
2. The increased energy and metabolic consumption of the paediatric population protects children from environmental hazards.	☐	☐	☐
3. The higher rate of cell growth during the paediatric age increases the risk of health effects caused by environmental factors.	☐	☐	☐
4. Environmental factors do not influence hormonal secretion during puberty.	☐	☐	☐
5. Nitrogen oxide from fossil fuels in the home and tobacco smoke causes redness and burns on the skin.	☐	☐	☐
6. Particles from animals exacerbate asthma crisis.	☐	☐	☐
7. Increased humidity at home improves respiratory diseases in children.	☐	☐	☐
8. Passive smoking is associated with the development of acute leukemias in children.	☐	☐	☐
9. Childhood leukemia incidence rates are higher in the areas most exposed to radon.	☐	☐	☐
10. Overexposure to solar ultraviolet radiations can damage the skin of adults more severely than that of children.	☐	☐	☐
11. During childhood more than half of the expected lifetime solar ultraviolet radiation is absorbed.	☐	☐	☐
12. Lead accumulates in the body affecting the nervous system.	☐	☐	☐
13. Chronic dietary exposure to mercury (fish and shellfish) is less toxic to children's central nervous system than to adults.	☐	☐	☐

	True	False	I don´t know
14. Exposure to pesticides increases the risk of developing attention deficit problems in school-aged children.	☐	☐	☐
15. Children born to smoking mothers during pregnancy are at risk of lower intellectual capacity.	☐	☐	☐
16. Exposure to organic solvents during fetal development can cause learning disabilities in children.	☐	☐	☐
17. Water containing nitrates can only cause intoxication during childhood.	☐	☐	☐
18. Chlorination of water forms sub-products from the disinfection process that have been classified as carcinogenic.	☐	☐	☐
19. The major source of childhood exposure to pesticides is through ambient air.	☐	☐	☐
20. The main route of exposure to mercury is through cereal intake.	☐	☐	☐
21. Exposure to lead through diet occurs mainly through fish intake.	☐	☐	☐
22. Food colourings and preservatives are associated with central nervous system problems.	☐	☐	☐
23. Genetically modified foods cause fewer allergic reactions in children.	☐	☐	☐
24. Schools and nurseries are environmentally safe places.	☐	☐	☐
25. Children are exposed to higher concentrations of air pollutants at home than outdoors.	☐	☐	☐
26. Parks and gardens are the areas with the least environmental pollutants where children can play.	☐	☐	☐

12.21. APPENDIX 21

ChEHS-Q (English version)

Children's Environmental Health Skills Questionnaire

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This questionnaire measures the overall perceived skills on sustainability and climate change issues and their effects on healthcare delivery. It could be used for nursing students.

Scoring instructions

The overall score is calculated by adding the scores that each student has assigned to each item.

The maximum score is 60 points (Skill Index 100%). The following index can be calculated from the score:

- Skill Index = Overall score / 60 X 100

In order to categorize the perceived skill level by nursing students, the following ranges are proposed:

→ > 90% = excellent skills
→ 89% - 80% = very good skills
→ 79% - 70% = good skills
→ 69% - 50% = insufficient skills
→ < 49% = poor skills

ChEHS-Q (English version)

Sustainability in healthcare means designing and delivering healthcare that uses resources in ways that don't prejudice future health and wellbeing. Next, there are a series of statements about children's environmental health skills. Please, tick the answer from 1 to 5 as you feel that each statement corresponds to you.

1. I am able to assess the main environmental risks to which a child is exposed.

   Strongly disagree 1 2 3 4 5 Strongly agree

2. I am NOT able to identify the environmental risks that can cause respiratory diseases in a child.

   Strongly disagree 1 2 3 4 5 Strongly agree

3. I am able to identify the environmental risks that can cause neoplastic diseases in a child.

   Strongly disagree 1 2 3 4 5 Strongly agree

4. I am NOT able to identify the environmental risks that can cause neurological disorders in a child.

   Strongly disagree 1 2 3 4 5 Strongly agree

5. I am able to provide health education to parents about the main contaminants in their child's food.

   Strongly disagree 1 2 3 4 5 Strongly agree

6. I am NOT able to identify the environmental risks in playgrounds.

   Strongly disagree 1 2 3 4 5 Strongly agree

7. I am able to provide health education to parents about actions to minimize environmental risks to which a child is exposed when playing outdoors.

   Strongly disagree 1 2 3 4 5 Strongly agree

8. I am NOT able to identify the environmental risks in a child's home.

   Strongly disagree 1 2 3 4 5 Strongly agree

9. I am able to provide health promotion to parents about environmental risks at home.

   Strongly disagree 1 2 3 4 5 Strongly agree

10. I am able to identify the environmental risks in a child's school.

    Strongly disagree 1 2 3 4 5 Strongly agree

11. I am NOT able to identify the actions needed to combat environmental risks in a child's school.

    Strongly disagree 1 2 3 4 5 Strongly agree

12. I do NOT feel able to do my job as a nurse in a Pediatric Environmental Health Specialty Unit.

    Strongly disagree 1 2 3 4 5 Strongly agree

Climate change has an important impact on health. The children are one of the most vulnerable population to environmental risks, especially under 5 years old. Nurses with adequate children´s environmental health competencies, defined as a set of related attitudes, knowledge and skills, can prevent or take care of different environmental problems. Therefore, the inclusion of environmental issues in the undergraduate nursing curriculum is essential. Nowadays, it is advantageous to take advantage of the use of new technologies, like blended-learning, to do so.

The general objectives of this research were four: (a) Build and validate a knowledge questionnaire and a skills questionnaire on children's environmental health for Spanish and English nursing students, (b) determine the attitudes, knowledge and skills related to children´s environmental health of students from different Spanish and United Kingdom universities, (c) evaluate the effectiveness of digital educational materials in training nursing students on children´s environmental health, and (d) assess the quality of the digital educational materials on children´s health and environment perceived by nursing students.

To fulfil the objectives, the research was developed in four main stages: (a) An observational cross-sectional study to validate the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q) in the Spanish context, (b) an observational, cross-sectional study to translate, adapt and validate the ChEHK-Q and the ChEHS-Q in the British context, (c) a multi-centre cross-sectional study to evaluate the attitudes, knowledge and skills of Spanish undergraduate nursing students, and (d) a quasi-experimental study of time series using pre-post educational intervention evaluation.

The ChEHK-Q and the ChEHS-Q were valid and reliable tools for measuring knowledge of and skills in children´s environmental health, respectively, among Spanish and British nursing students; the reliability values for the items and people were, .98, .70, .87 and .76, respectively, for ChEHK-Q and ChEHS-Q in the Spanish context; and .96, .79, .98 and .89, respectively, for ChEHK-Q and ChEHS-Q in the British context. Spanish student nurses had positive attitudes toward dealing with environmental problems (87.53% had at least good attitudes), but they lacked knowledge (only 20.35% had at least good knowledge) and skills (only 47.20% students had at least good skills) to deal environmental problems. Child health nursing students from University of Plymouth also need more training to manage environmental problems or illness in children (22.41% of the Plymouth nursing students had good children's environmental health knowledge and 33.62% of them had good children's environmental health skills); in contrast, the 97.45% of them had good attitudes.

The level of attitudes, knowledge and skills of nursing students improved after the e-NurSus Children intervention ($p < .001$); it improved environmental health knowledge the most (39.02%), followed by skills (29.98%) and finally attitudes (15.81 %). In University of Jaén, skills improved the most (42.33%), followed by knowledge (37.61%) and attitudes (22.96%); and in University of Plymouth, knowledge (40.38%) improved the most, followed by skills (21.70%) and attitudes (11.06%). The quality of the educational materials was above average in all cases (in a scale 1 to 10). Accessibility of textual content was the best scored dimension, 7.94, and Portability the lowest, 7.05.

These findings clearly show the necessity to change the nursing curricula and include topics on children's environmental health, because nursing students have positive attitudes towards change but do not have the knowledge and skills needed to manage problems or illness caused by the environment. The e-NurSus Children intervention is useful to increase the attitudes, knowledge and skills related to children's environmental health among nursing students.