

# Main characteristics of preventive postural hygiene training programs in the educational field

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## ABSTRACT

**Objective:** To determine the state of the art regarding preventive training programs on postural hygiene and back health in an educational context. **Introduction:** The prevalence of non-specific back pain in population reaches alarming figures and its causes are largely preventable. Adequate training in postural education is necessary along students' academic career. **Method:** Retrospective descriptive study, using the PRISMA method. **Results:** 61 original articles published from 2017 to 2021 have been analysed. **Discussion:** Postural education programs have demonstrated their effectiveness and have provided benefits for the participating students.

**Keywords:** Review, Health literacy, Postural education, Educational intervention, Back pain.

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## INTRODUCTION

Students in schools frequently adopt inadequate and/or maintained postures for long periods of time, in class and in everyday life, which can have important consequences on their development. One of these most common consequences is back pain, mainly low back pain (Maher et al., 2017), which some studies link directly to the adoption of inappropriate postures (Da Rosa et al., 2017; Maher et al., 2017; Dullien et al., 2018; Minghelli, 2020a) and are mostly not pathological in origin (Illeez et al., 2020).

The high prevalence of this condition makes it a real public health problem (Maher et al., 2017; Subbarayalu and Ameer 2017; Amyra-Natasha et al., 2018; Clark et al., 2018; Dullien et al., 2018; Jonsdottir et al., 2019) with important implications for health services (Minghelli, 2020a; Garvick et al., 2019). It also carries future implications in adulthood (Coenen et al., 2017; Assiri et al., 2020), including being the leading cause of disability globally (Hartvigsen et al., 2018). This problem is not only prevalent among the adult population, but increasingly affects adolescent and child learners (Dianat et al., 2017; Maher et al., 2017; Dullien et al., 2018; Rodríguez-Oviedo et al., 2018).

Given that postures performed during everyday life are modifiable elements of lifestyle, interventions can be used to improve the posture of children and adolescents (Mantilla et al., 2021).

In Spain, according to data from the Annual Report of the National Health System (Ministry of Health, 2018), 18.5% of the Spanish adult population suffers from back pain, being more frequent in women than in men. This problem affects people of all ages (Hartvigsen et al., 2018; Vlaeyen et al., 2018). Amado-Merchán (2020) estimates that around 80% of the population will suffer from back pain at some point in their lives. But other studies put the prevalence as high as 95% (Kalki et al., 2020). Without adequate care, it will have repercussions in the personal, occupational and social spheres, and can become highly limiting for people's daily lives and increase healthcare costs (Amado-Merchán, 2020).

International studies reveal a worldwide situation very similar to the Spanish situation and it is predicted that the problem will increase globally in the coming decades (Hartvigsen et al., 2018). Back pain and specifically low back pain is considered a major public health problem (Maher et al., 2017; Subbarayalu and Ameer 2017; Amyra-Natasha et al., 2018; Clark et al., 2018; Dullien et al., 2018; Jonsdottir et al., 2019) that directly affects the respective national health services (Minghelli, 2020a; Garvick et al., 2019).

Furthermore, back problems that arise in late adolescence have a high probability of persisting into adulthood (Santos et al., 2021; Assiri et al., 2020; Illeez et al., 2020; Paranjape and Ingole, 2018; Dugan, 2018; Coenen et al., 2017; de-Oliveira-Saes and Flores-Soares, 2017).

Based on these approaches and considering that education is one of the cornerstones for intervening in back pain (O'Sullivan et al., 2019), the inclusion of postural education as a content of Health Education is fully justified in the training process of students (Mata-Bazán and Campos-Cornejo, 2018; Chacón-Borrego et al., 2018).

The period corresponding to the compulsory school age is a sensitive phase for working on health-related contents (Wawrzyniak et al., 2017) that contribute to the development of competences that accompany the individual throughout his or her life (Amado-Merchán, 2020; Chacón-Borrego et al., 2018; Mata-Bazán and Campos-Cornejo, 2018). Health promotion plays a fundamental role in the development of personal skills that favour health-oriented behavioural changes and the promotion of healthy lifestyles (Kabasakal et al.,

2020; Pinto and Silva, 2020). Furthermore, children and adolescents suffer from back problems from an early age, coinciding with their entry into the educational system, and the prevalence figures increase from adolescence onwards (MacDonald et al., 2017).

With regard to the promotion of healthy habits, the area of Physical Education plays a leading role in the education of students (Morrish and Neesam, 2021; Amado-Merchán, 2020; Mata-Bazán and Campos-Cornejo, 2018). Authors such as Morrish and Neesam (2021) recommend promoting the interdisciplinary treatment of health together with the rest of the areas, so that such learning is as meaningful as possible and lasts into adulthood (Ghobadi et al., 2018; Mata-Bazán and Campos-Cornejo, 2018). This requires a coordinated approach from the teaching team, where the role of teachers is vital, both as promoters of healthy habits in the classroom and as facilitators of the participation of the entire educational community (Chacón-Borrego et al., 2018).

Postural education programs have positive results, both in the acquisition of knowledge and in the improvement of behaviours related to back health. However, we know that the effects diminish with the passage of time, so it would be interesting to maintain these programs throughout the students' educational process, in order to acquire healthy habits that last over time (Amado-Merchán, 2020).

## METHOD

### **Study design**

This systematic review responds to a retrospective descriptive design, for which the PRISMA method - Preferred Reporting Items for Systematic Reviews and Meta-Analysis- (Page et al., 2021) was used.

### **Search strategy**

A systematic search of recent literature was carried out in the following databases: Scopus and Web Of Science (WOS). The search range was from 2017 to 2021 in both databases. This search was conducted between January and May 2022 and aimed to find publications related to the treatment of postural hygiene in the educational setting, specifically, in children and young people in schools. The search formula used was the following: (TITLE ("postur\* educat\*" OR "postur\* hygiene" OR "postur\* habits" OR "back care" OR "back health" OR "back pain" OR "LBP" OR "ergonom\*" OR "postur\* health\*" OR "postur\* habit\*" OR "postur\* behavior\*" OR "back postur\*" OR "back educat\*") AND ABS (school\* OR children OR student\* OR schoolchildren OR adolescent\* OR teenager\*)).

### **Data selection and extraction**

The bibliometric analysis process took place in two phases. In the first phase, the results obtained in the initial search were screened. Only original research articles published in scientific journals were included and case studies, systematic reviews, books, conferences, etc. were excluded. The search result returned 468 and 428 articles from Scopus and WOS, respectively, to be filtered. Of this initial number, 317 articles were eliminated before screening, because of being duplicated. The records identified and selected for screening (n = 579) were then dumped into the RefWorks bibliography management tool. From this application, a first screening of non-relevant articles was carried out, according to their title and abstract. 482 records were excluded at this stage of the process. Thus, a total of 97 records were evaluated for eligibility. In the second phase of the screening, the full texts of the articles were obtained and the data and information relating to the categories and subcategories of analysis shown in Table 1 below were extracted.

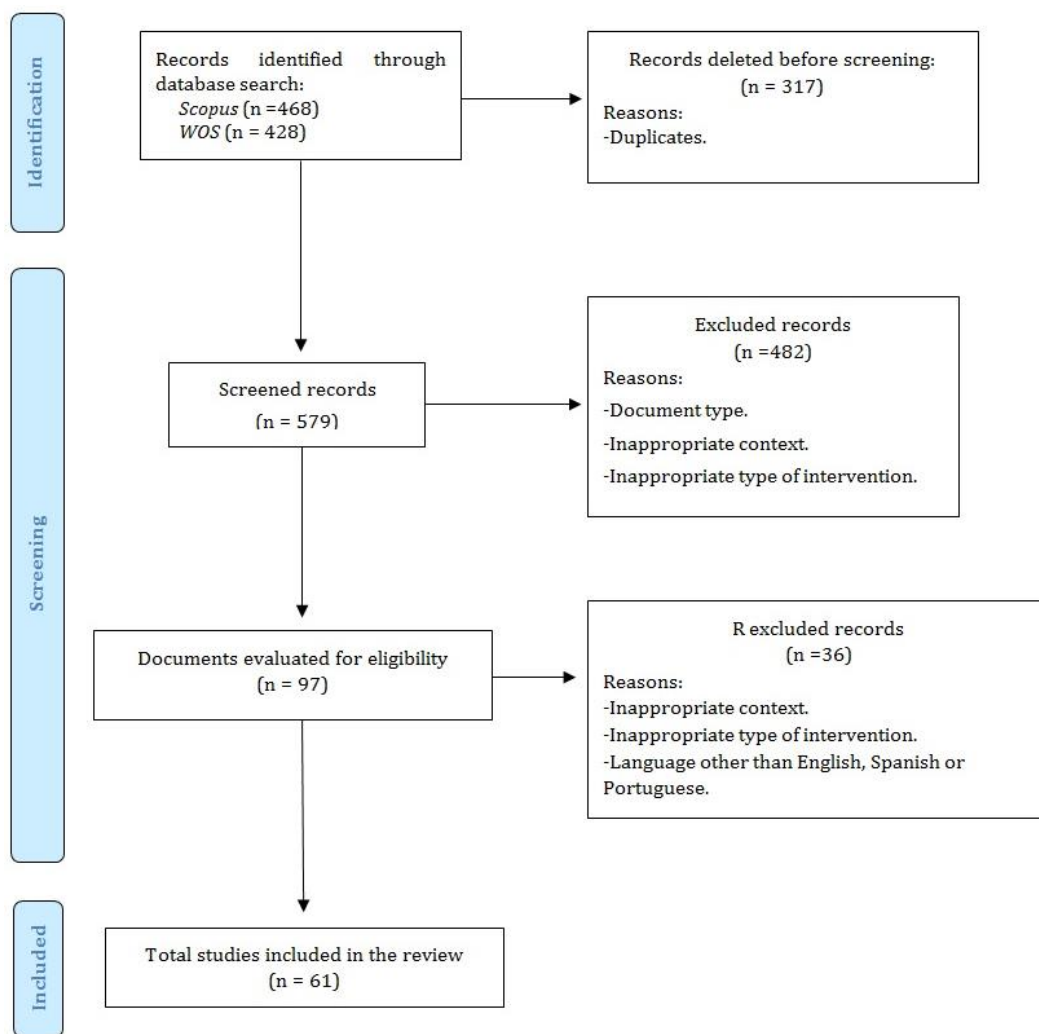


Figure 1. Flowchart of the studies analysed during the review process.

Table 1. Categories and subcategories of analysis.

Categories	Subcategories
Object of study	Intervention programs in postural education.
	Validation of research instruments.
	Use of electronic devices for posture analysis.
	Prevalence of back pain in children, adolescents, and young adults.
General description	Year of publication.
	Magazines of publication and number of articles in each one.
	Authors: number of authors in each article and main authors.
Research method	Countries and continents of publication.
	Type of design.
	Type of methodology.
Content analysis	Sample characteristics: size, age and educational stage.
	Contents, instruments and results of intervention programs.
	Instruments and results of instrument validation studies.
	Device for posture analysis: description of the instrument.
	Instruments and results of back pain prevalence studies.

In this second screening phase, 36 records were excluded. The remaining 61 records were finally included in the review and the information corresponding to the categories described above was analysed, classified and recorded in a Microsoft Excel spreadsheet. This procedure is summarized and represented in the PRISMA flow chart in Figure 1.

## RESULTS

The analysis of the records found was carried out according to the selected categories and subcategories of analysis.

### **Subject matter of the research studies**

According to the type of research carried out, 11 studies (18%) were interventions in the educational setting (primary and/or secondary level) consisting of the implementation of postural education intervention programs in the school population (school-age students and young adults). Another 4 studies (7%) consisted of validations or cultural adaptations of instruments (health questionnaires). We also found 1 study (2%) describing the applicability of an electronic device in posture analysis. Finally, 45 studies (74%) analysed the incidence of back pain in school populations and the causes and risk factors associated with it.

### **Year of publication**

Of the 61 records analysed, 7 studies (11%) were published in 2017, 8 studies (13%) in 2018, 10 studies (16%) in 2019, 20 studies (33%) in 2020 and 16 studies (26%) in 2021.

### **Type of design**

Following the classification of Dankhe (1986): 12 studies (19.7%) are of the explanatory type, 45 studies (73.8%) are of the correlational type and 4 studies (6.5%) are of the descriptive type.

### **Methodology**

Regarding the type of methodology used in the research: 60 studies (98%) are quantitative and 1 study (2%) is qualitative.

### **Journals and number of articles published in them**

According to the journals and the number of articles published in them, we find: 5 articles (8%) published in the *International Journal of Environmental Research and Public Health*, 3 articles (5%) in the *Journal of Back and Musculoskeletal Rehabilitation*, 2 articles (3%) in *BMC Musculoskeletal Disorders*, *BMC Public Health*, *British Journal of Pain*, *Spine*, *Sportis*, *Revista Técnico-Científica del Deporte Escolar*, *Educación Física y Psicomotricidad*, *Sustainability* and *Work*. In the remaining journals (n = 39), 1 article (2%) was published in each journal.

### **Authors**

According to the number of contributing authors and co-authors, we found: 3 articles (5%) were written by 1 author, 6 articles (10%) by 2 authors, 9 articles (15%) by 3 authors and 43 articles (70%) by 4 or more authors.

As for the authors listed as principal investigators (single author or first author of the research team): Minghelli and Miñana-Signes appear most frequently, with 3 articles (5%) each. Akbari-Chehrehbargh, Sainz de Baranda, González-Gálvez and Kedra appear as principal investigators in 2 articles (3%) each. The rest of the first authors (n = 47) appear in only 1 article (2%) each.

### **Literature production by country and continent**

The countries where most studies have been carried out are Spain, with 15 articles (25%), Brazil, with 10 articles (16%) and Iran, with 6 articles (10%). India, Italy, Poland and Portugal have 3 articles (5%) each. In the USA, Malaysia and Indonesia, 2 studies (3%) were conducted in each country. In the remaining countries (n = 12), 1 study (2%) took place in each.

Grouping the countries by continent, Europe covers the most research with 29 articles (48%), followed by Asia with 16 (26%), South America with 11 (18%), Africa with 3 (5%) and North America with 2 (3%).

### **Characteristics of the sample analysed**

The sample size used in the studies varies in a range between 18 and 11619 persons. We found: 15 studies (25%) with samples larger than 1000 persons; 11 studies (18%) with samples between 500 and 999 persons; 22 studies (36%) with samples between 100 and 499; 5 studies (8%) with samples between 50 and 99 persons; 6 studies (10%) with samples between 18 and 49 persons and 2 studies (3%) which, due to their characteristics, were not implemented in any population group.

Regarding the sample size according to the object of study of the research: 5 articles (45.5%) of postural education intervention programmes were implemented in groups of 18-49 people, 1 article (9%) in groups of 50-99 people and 5 articles (45.5%) in groups of 100-499 people.

In the research on instrument validations: 3 studies (75%) were conducted with samples of 100-499 persons; 1 study (25%) was conducted in a group of 500-999 persons.

The only study found on the use of an electronic device for posture analysis did not require any population sample.

Finally, according to the studies on the prevalence of back pain: 1 investigation (2.2%) did not include any population sample; 2 articles (4.4%) were implemented in groups of 18-49 people; 3 studies (6.7%) in groups of 50-99 people; 14 studies (31.1%) were implemented in groups of 100-499 people; 14 studies (31.1%) were implemented in groups of 500-999 people; 1 study (25%) was implemented in a group of 500-999 people; 15 studies (33.3%) in groups of more than 1000 people.

The registered studies included students from public, private and charter schools and they were 6-20 years old.

### **Content analysis**

#### *a) Intervention programs in postural education*

These studies have been carried out in experimental groups made up of pupils in educational centres and the results (post-test) were analysed in comparison with the previous data (pre-test).

##### *a.1) Program content*

The main contents covered by the educational programs analysed are:

- Anatomical and functional concepts of the back (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Akbari-Chehrehbargh et al., 2020a; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dullien et al., 2018; Dos-Santos et al., 2017).
- Analysis of postures in classroom and daily life activities:

- Posture while sitting (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Blanco-Morales et al., 2020; Akbari-Chehrehbargh et al., 2020a; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dullien et al., 2018).
- Posture while writing while seated (Minghelli et al., 2021; Minghelli, 2020b; Miñana-Signes et al., 2019; Dos-Santos et al., 2017).
- Posture while using the computer while seated (Serrano-Durá et al., 2021; Blanco-Morales et al., 2020; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Sellschop et al., 2018; Dos-Santos et al., 2017).
- Transport of the school bag (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Blanco-Morales et al., 2020; Akbari-Chehrehbargh et al., 2020a; Minghelli, 2020b; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dos-Santos et al., 2017).
- Weight distribution inside the school bag (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Akbari-Chehrehbargh et al., 2020a; Minghelli, 2020b; Cabrera-González et al., 2020; Miñana-Signes et al., 2019).
- Maximum school bag weight (Minghelli et al., 2021; Serrano-Durá et al., 2021; Akbari-Chehrehbargh et al., 2020a; Minghelli, 2020b; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dullien et al., 2018).
- Decubitus posture (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dos-Santos et al., 2017).
- Posture while watching TV or playing games (Minghelli et al., 2021; Serrano-Durá et al., 2021; Cabrera-González et al., 2020; Miñana-Signes et al., 2019).
- Posture while typing messages on a mobile phone (Minghelli et al., 2021; Minghelli, 2020b; Miñana-Signes et al., 2019).
- Standing posture (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Akbari-Chehrehbargh et al., 2020a; Cabrera-González et al., 2020; Miñana-Signes et al., 2019).
- Posture when reaching for an overhead object (Serrano-Durá et al., 2021; Cabrera-González et al., 2020; Miñana-Signes et al., 2019).
- Posture when lifting a heavy object from the ground (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Akbari-Chehrehbargh et al., 2020a; Minghelli, 2020b; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dullien et al., 2018; Dos-Santos et al., 2017).
- Posture when lifting a light object from the ground (Minghelli et al., 2021; Mantilla et al., 2021; Akbari-Chehrehbargh et al., 2020a; Minghelli, 2020b).
- Posture when transporting from one place to another:
  - Shopping bags (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dos-Santos et al., 2017).
  - A heavy object (Minghelli et al., 2021; Serrano-Durá et al., 2021; Akbari-Chehrehbargh et al., 2020a; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dullien et al., 2018; Dos-Santos et al., 2017).
- Consequences of incorrect and/or prolonged postures (Minghelli et al., 2021; Serrano-Durá et al., 2021; Cabrera-González et al., 2020; Miñana-Signes et al., 2019).
- Muscle strengthening exercises (Serrano-Durá et al., 2021; Akbari-Chehrehbargh et al., 2020a; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dullien et al., 2018).

- Flexibility exercises (Blanco-Morales et al., 2020; Akbari-Chehrehbargh et al., 2020a; Cabrera-González et al., 2020; Miñana-Signes et al., 2019).

Other contents analysed in the intervention programs recorded were:

- Analysis of postures in classroom and daily life activities:
  - Sitting in a seat without a backrest (Dos-Santos et al., 2017).
  - Posture when getting out of bed (Minghelli et al., 2021).
  - Posture while putting on shoes (Akbari-Chehrehbargh et al., 2020a).
  - Posture while sweeping the floor (Miñana-Signes et al., 2019).
  - Posture while brushing teeth (Miñana-Signes et al., 2019).
  - Proper jaw posture when chewing (Dos-Santos et al., 2017).
- Analysis of posture during exercise and physical activities (Cabrera-González et al., 2020; Miñana-Signes et al., 2019).
- Breaks during prolonged postures (Minghelli et al., 2021).
- Exercises for rest intervals (Minghelli et al., 2021; Mantilla et al., 2021).
- Massage application (Blanco-Morales et al., 2020).
- Relaxation exercises (Cabrera-González et al., 2020; Miñana-Signes et al., 2019).
- Balance exercises (Cabrera-González et al., 2020; Dullien et al., 2018).
- Examples of back-healthy sports (Dullien et al., 2018).
- Levels of motivation and perception of effort (Serrano-Durá et al., 2021).
- Level of daily physical activity (Akbari-Chehrehbargh et al., 2020a).

#### *a.2) Instruments used*

The instruments most commonly used to obtain the results were:

- A theoretical test of postural awareness (Minghelli et al., 2021; Mantilla et al., 2021; Serrano-Durá et al., 2021; Miñana-Signes et al., 2019; Dullien et al., 2018; Sellschop et al., 2018; Dos-Santos et al., 2017).
- A practical performance test (Minghelli et al., 2021; Minghelli, 2020b; Dullien et al., 2018; Dos-Santos et al., 2017).
- A questionnaire on the presence of back pain (Minghelli et al., 2021; Akbari-Chehrehbargh et al., 2020a; Cabrera-González et al., 2020; Miñana-Signes et al., 2019; Dullien et al., 2018).
- Socio-demographic data recording (Blanco-Morales et al., 2020; Akbari-Chehrehbargh et al., 2020a).
- Physical muscular endurance tests (Serrano-Durá et al., 2021; Cabrera-González et al., 2020; Dullien et al., 2018).
- Other methods:
  - o Motivation and effort rating scales (Serrano-Durá et al., 2021).
  - o Self-perception scales of efficacy in postural behaviour (Akbari-Chehrehbargh et al., 2020a).
  - o Focus groups, field notes, diaries and interviews (Blanco-Morales et al., 2020).
  - o Clinical examination (Dullien et al., 2018; Sellschop et al., 2018).
  - o Anthropometric data (Dullien et al., 2018).

#### *a.3) Analysis of the records on postural education intervention programs found*

A comparative study of 2 intervention models based on the Back School (Minghelli et al., 2021) showed that the programme with longer duration, weekly frequency and practice obtained better results in increasing ergonomic knowledge of posture, as well as reducing back pain. On the other hand, the intervention based on the Back Care Education Programme (Mantilla et al., 2021) also obtained better results in the theoretical-practical questionnaires of the intervention groups compared to the control group.



The intervention carried out through a teaching methodology based on gamification (Serrano-Durá et al., 2021) obtained significant improvements in terms of content assimilation, compared to the traditional methodology, although only in female students. The results in terms of motivation and self-perception of effort were satisfactory in the whole sample.

Interventions based on school physiotherapy programs (Blanco-Morales et al., 2020; Minghelli, 2020b) contributed to: theoretical-practical training on the adoption of correct posture, reduction of back pain in all adolescents involved, greater awareness of the consequences of not adopting proper posture and increased motivation to make changes in their daily postural habits (Blanco-Morales et al., 2020).

On the other hand, it was also found that most adolescents adopt an inadequate posture when performing activities at school or in everyday life, which can lead to musculoskeletal disorders. These results point to the need for health promotion at school to encourage postural literacy to prevent posture-related back problems and pain (Minghelli, 2020b).

The theory-based back care intervention (T-Bak) showed positive results in terms of increasing the back care knowledge of Primary School pupils. For this reason, the implementation of intervention programs is recommended in educational institutions at this school stage (Akbari-Chehrehbargh et al., 2020a).

The intervention based on a lesson plan of postural education content (Cabrera-González et al., 2020) is, according to its authors, easy to apply as it is specifically designed for inclusion in formal education. In it, the results show significant improvements in knowledge of back health and a high prevalence of students with low back pain was found. Low back pain is a public health problem and adolescence is a stage characterized by the appearance of this ailment. Therefore, the benefits of this study could have positive consequences in the prevention of back pain, as well as other health problems. On the other hand, this study also showed that there is little knowledge about postural attitudes and habits that can be dangerous for health. In any case, didactic interventions of a curricular nature mean that teachers assume the responsibility of contributing to the promotion of healthy habits that have significant consequences in the lives of students.

In another postural education intervention, framed within the Postural Education Program for Schoolchildren (Dos-Santos et al., 2017), students improved their theoretical knowledge of back care and postural attitudes in most of the activities of daily living analysed, with respect to the values recorded in the pretest.

An educational intervention program in back health (Miñana-Signes et al., 2019) contributed to improving both knowledge and the acquisition of postural habits in activities of daily living. According to the authors of the study, Physical Education classes are the ideal environment for carrying out educational programs on back health. It is necessary to carry out more studies with validated instruments in order to continue improving intervention programs.

A specific intervention on computer use (Sellschop et al., 2018) obtained positive results in terms of the adoption of ergonomic sitting postures, working in front of the screen. This study showed the importance of early intervention in the school environment to increase efficient postural behaviour and thus contribute to a positive impact on the health system.

Other studies (Dullien et al., 2018) despite improving the postural habits of the participants did not obtain satisfactory results in improving back pain, as the prevalence could not be reduced below 30%. Long duration

physical activity, excessive weight of backpacks and sitting for long periods of time were evidenced as the 3 main causes of back pain.

*b) Validation of research instruments*

In the records analysed during the systematic search, 4 recent studies on validation of new research instruments related to the implementation of postural education programs were found. These articles were separated into a different subcategory.

The first of the studies (Szilagyi et al., 2021) aims to develop and validate a back care knowledge questionnaire for use with children aged 6-10 years. The current literature makes validated questionnaires available to researchers for pupils from 14 years of age, but there is a shortage of validated instruments for younger ages, despite the fact that postural education intervention programs are recommended from the age of 4 years. The result was satisfactory and validation showed the instrument to be valid and reliable.

The second study (Miñana-Signes et al., 2021b) aims to make a cultural adaptation of an instrument already validated in the original country and language. The Back Pain and Body Posture Evaluation Instrument - BackPEI (Back Pain and Body Posture Evaluation Instrument). For this purpose, the authors of the study carried out a translation into Spanish and a reliability test of the instrument. The results were satisfactory and similar to those obtained with the original Brazilian version.

In the third article (Akbari-Chehrehbargh et al., 2020b) the aim of the researchers is to develop and validate a questionnaire to measure healthy spine-related behaviours in school populations. The lack of assessment instruments that measure postural learning based on Social Cognitive Theory has led them to design the Back-care Behavior Assessment Questionnaire (BABAQ). The results of its development and validation were positive and make the BABAQ a valid instrument.

The last article (Monfort-Pañego and Miñana-Signes, 2020) aims to develop and validate a Questionnaire to Evaluate the Back-health related postural Habits in dAiLy actiVitiES (BEHALVES) of adolescents. The results confirmed that the questionnaire is a valid and reliable instrument for assessing the postural habits of students during activities of daily living.

*c) Use of electronic device for postural analysis*

Among all the recent studies recorded, only Lubkowska (2018) described the applicability of an electronic device as an aid for the assessment of body posture. The Wiva sensor is placed on the joint to be analysed and uses Bluetooth technology to send precise information on the movement of the joint, allowing the ranges of movement considered healthy or optimal for the objective of the intervention to be controlled.

*d) Prevalence of back pain in the school population and its causes and risk factors*

The last of the subcategories is also the one on which most studies have been carried out. The scientific literature contains a large number of studies on the prevalence and risk factors for back pain in children, adolescents and young adults in the formal educational system.

*d.1) Instruments used*

The most commonly used instrument for obtaining results was the self-administered questionnaire, although the personal interview was used in 4 of the articles consulted (Iacovelli et al., 2021; Minghelli, 2020a; Akbar et al., 2019; Spiteri et al., 2017) and the observation sheet in 4 studies (Vidal-Conti et al., 2021; Illeez et al.,

2020; Sukartini et al., 2020, Paranjape and Ingole, 2018). The majority of the researches opted for the combined use of several instruments. Regarding the type of questionnaire, there is diversity in its use. Several authors implemented standardized instruments (Miñana-Signes et al., 2021a ; Noll et al., 2021; Vitta et al., 2021; Bento et al., 2020; González-Gálvez et al., 2020; Schwertner et al., 2020; Galozzi et al., 2019; Aparicio-Sarmiento et al., 2019; de-Oliveira-Saes and Flores-Soares, 2017; Da Rosa et al., 2017; Meziat-Filho et al., 2017), while others opted for adaptations of standardized questionnaires (Iacovelli et al., 2021; Kedra et al., 2021; Masiero et al., 2021; Muñoz-Serrano et al., 2021; Layuk et al., 2020; Ayed et al., 2019, Khalil and Alrubaey, 2019) and, in other studies, ad-hoc designed instruments were applied (Iacovelli et al., 2021; Kedra et al., 2021; Muñoz-Serrano et al., 2021; Galozzi et al., 2019; Aparicio-Sarmiento et al., 2019; Rodríguez-Oviedo et al., 2018; Mohammadi et al., 2017).

*d.2) Analysis of the records found on the prevalence of back pain in schoolchildren*

Low back pain is the most common musculoskeletal complaint related to the back and spine (González-Gálvez et al., 2021). Kalki et al. (2020) estimate that up to 95% of the population will suffer back pain at some point in their lives.

In the articles analysed, the authors recorded a wide range of figures for the prevalence of back pain: 33-90% of those surveyed suffered pain at some time in their lives (Vidal-Conti et al., 2021; Miñana-Signes et al., 2021a; Masiero et al., 2021; Kalki et al., 2020; Schwertner et al., 2020; Galozzi et al., 2019; Noormohammadpour et al., 2019; Akbar et al., 2019; Kiat et al., 2018; Paranjape and Ingole, 2018); 19-74% in the last year (Kedra et al., 2021; Vitta et al., 2021; Miñana-Signes et al., 2021a; Bento et al., 2020; Minghelli, 2020a; Fabricant et al., 2020; Sainz de Baranda et al., 2020a and 2020b; Kedra et al., 2019; Rodríguez-Oviedo et al., 2018; Meucci et al., 2018); 27-80% in the last month (Santos et al., 2021; Ayed et al., 2019; Oka et al., 2019; Khalil y Alrubaey, 2019; Noormohammadpour et al., 2019; Akbar et al., 2019; Hadziomerovic et al., 2018; Spiteri et al., 2017; Dianat et al., 2017); 11-45% in the last 7 days (Miñana-Signes et al., 2021a; Vidal-Conti et al., 2021; Sainz de Baranda et al., 2020a and 2020b; de-Oliveira-Saes and Flores-Soares, 2017); 9-32% point prevalence at the time of answering the questionnaire (Vidal-Conti et al., 2021; Miñana-Signes et al., 2021a; Minghelli, 2020a, Schwertner et al., 2020; Shuhaimi and Rahman, 2020).

The presence of pain is not only more common in women, but also appears with greater intensity (Iacovelli et al., 2021). However, other studies (Miñana-Signes et al., 2021a; González-Gálvez et al., 2021; Assiri et al., 2020) found no relationship between gender and the higher prevalence of back pain.

According to most of the studies consulted, the prevalence increases in parallel with the age of the students (Kedra et al., 2021; Miñana-Signes et al., 2021a; Noll et al., 2021; González-Gálvez et al., 2020; Minghelli, 2020a; Fabricant et al., 2020; Ayed et al., 2019; Aparicio-Sarmiento et al., 2019; Kedra et al., 2019; Meucci et al., 2018; de-Oliveira-Saes y Flores-Soares, 2017). However, Assiri et al. (2020) did not find this correlation.

The scientific literature states that the prevalence of back pain in adolescents is very high, with important consequences on their quality of life (Iacovelli et al., 2021; Santos et al., 2021; Masiero et al., 2021; González-Gálvez et al., 2020; Ayed et al., 2019; Galozzi et al., 2019). Masiero et al. (2021) recorded 14% of students reporting non-specific disabling low back pain at some point in their lives. The first manifestations of this condition are detected from the age of 10 years (Miñana-Signes et al., 2021a) and there is a high probability that it will persist into adulthood (Santos et al., 2021; Assiri et al., 2020; Illeez et al., 2020; Paranjape e Ingole, 2018; de-Oliveira-Saes y Flores-Soares, 2017).

Several studies highlight the burden this problem places on the health care system (Minghelli, 2020a; Garvick et al., 2019). Hence, there are authors, such as Kalki et al. (2020), who consider back pain to be one of the most underestimated public health problems.

The causes of back pain in childhood and youth are as diverse as in adults, with those of mechanical origin being the most frequent and not those caused by disease (Illeez et al., 2020).

Back pain was associated with prolonged sitting (Kemta et al., 2021; Masiero et al., 2021) and incorrect sitting posture (Minghelli, 2020a; Meziat-Filho et al., 2017). Minghelli (2020a) highlights the importance of this aspect, given the high number of hours' students spend sitting in schools. However, Sainz de Baranda et al. (2020a) found no correlation between the way of sitting and the appearance of back pain, despite finding that most students sat inappropriately in class.

Other risk factors pointed out by the scientific literature are: incorrect adjustments of school furniture (Ayed et al., 2019; Dianat et al., 2017); posture during the handling of electronic devices and the time spent using them (Vitta et al., 2021; Masiero et al., 2021; Bento et al., 2020; Minghelli, 2020a; Ayed et al., 2019); time spent watching television (Santos et al., 2021; Noll et al., 2021; Bento et al., 2020; Ayed et al., 2019; Oka et al., 2019; Paranjape e Ingole, 2018; Meziat-Filho et al., 2017); lack of adequate rest (Masiero et al., 2021; Muñoz-Serrano et al., 2021); high BMI (González-Gálvez et al., 2020; Spiteri et al., 2017); presence of lumbar hyperlordosis (Sainz de Baranda et al., 2020b); family history of back pain (Kemta et al., 2021; Noll et al., 2021; Masiero et al., 2021; Oka et al., 2019; Noormohammadpour et al., 2019; Dianat et al., 2017); passive smoking (Noormohammadpour et al., 2019).

Low physical activity was associated with the development of back pain (González-Gálvez et al., 2021; Masiero et al., 2021; González-Gálvez et al., 2020; Schwertner et al., 2020). Sedentary lifestyles affect key aspects of postural control, such as core toning and hamstring flexibility (González-Gálvez et al., 2021). This is why authors such as Schwertner et al., (2020), relate the practice of Physical Education at school to a protective factor against back pain.

Other studies found no direct relationship between back pain and the following risk factors: lack of rest (Schwertner et al., 2020); use of electronic screens (Schwertner et al., 2020; Dianat et al., 2017); time spent in sedentary activities (González-Gálvez et al., 2021; Dianat et al., 2017); student BMI (González-Gálvez et al., 2021; Masiero et al., 2021; Schwertner et al., 2020).

The incidence of back pain is directly linked to the prolonged use of school bags (Ayed et al., 2019; Khalil y Alrubaey, 2019; Dianat et al., 2017) and to the weight of school bags (Santos et al., 2021; Kedra et al., 2021; Layuk et al., 2020; Kalki et al., 2020; Shuhaimi y Rahman, 2020; Ayed et al., 2019; Noll et al., 2021; Assiri et al., 2020; Akbar et al., 2019; Rodríguez-Oviedo et al., 2018; Kiat et al., 2018; Hadziomerovic et al., 2018; Paranjape e Ingole, 2018; Spiteri et al., 2017). Although there are studies that found no relationship with school bag weight (Kemta et al., 2021; Oka et al., 2019; Dianat et al., 2017).

The way the backpack is carried also influences the incidence of back pain for some authors (Noll et al., 2021; Assiri et al., 2020; Khalil y Alrubaey, 2019; Rodríguez-Oviedo et al., 2018). However, for other researchers there is no such relationship (González-Gálvez et al., 2021) and there is even a study (Khalil and Alrubaey, 2019) that points out that the simple fact of using a school bag is already a risk factor in itself.

There are studies that have shown a low level of knowledge about back health on the part of the participating students (Aparicio-Sarmiento et al., 2019; Kedra et al., 2019). This finding justifies the need to carry out educational interventions in schools themselves, as proposed by numerous authors (Vidal-Conti et al., 2021; Alami et al., 2020; Minghelli, 2020; Schwertner et al., 2020; Assiri et al., 2020; Ayed et al., 2019; Kedra et al., 2019; Kiat et al., 2018; Paranjape e Ingole, 2018; Mohammadi et al., 2017; de-Oliveira-Saes y Flores-Soares, 2017).

## DISCUSSION

Scientific production is considerably higher in the last two years and has been mainly developed by European scientists, especially Spanish scientists. On the other hand, Africa's low scientific production stands out, which could be attributed to lower investment in research, fewer researchers and/or limited international collaboration (Venkata et al., 2021), and the reduced contribution of North American studies. It is worth highlighting the case of Oceania, which despite having well-established economies, has zero research output on the subject.

With regard to the type of design (Dankhe, 1986), all the studies corresponding to intervention programmes in postural education, due to their experimental nature, are of an explanatory type. While the studies of validation of instruments and the great majority of those on the prevalence of back pain are of the correlational type. Lastly, the only study related to the use of an electronic device for the evaluation of posture is descriptive, since it does not include any type of intervention or analysis between variables. It is limited to describing the functioning and usefulness of the device as a tool for assessing body posture.

On the other hand, quantitative methodology is the preferred option in the studies found in this review. Only one article (Blanco-Morales et al., 2020) mentions qualitative methodology.

Regarding the publication medium, most of the studies were included in specialised journals of public health, health promotion and Physical Education and Sport, and elaborated by a team of 4 or more authors. Among the main authors who appear most frequently, we highlight Minghelli and Miñana-Signes, from Italy and Spain, respectively, who are authors of 3 articles each. In the case of Minghelli, 2 of them as sole author.

Most of the studies highlight the very high prevalence of back pain in the school population in formal education and the effects on their quality of life. One study (Masiero et al., 2021) even highlights that the number of students who claimed to suffer or have suffered disabling back pain at some point in their lives was 14%. This is a very high figure, given that we are talking about back pain that is disabling for everyday life and non-specific, i.e. back pain that cannot be attributed to a specific cause (Maher et al., 2017).

Although the percentage range is wide and varies between studies, the worst figures found determine the incidence of back pain at some point in life in 90% (Kalki et al., 2020) of students surveyed, 74% (Kedra et al., 2019) suffered pain in the last year, 80% (Hadziomerovic et al., 2018) in the last month, 45% (de-Oliveira-Saes and Flores-Soares, 2017) in the last week and 32% (Shuhaimi and Rahman, 2020) at the time of the study. In line with these data, there are authors (Kalki et al., 2020) who estimate that up to 95% of the population will suffer from this ailment at some point in their lives and that the origin of this ailment is not attributable to pathologies in most cases (Illeez et al., 2020), so prevention strategies are recommended, from an early age and from the educational centres themselves, to promote lifestyle habits related to back health.

In the literature consulted, there is no clear consensus on the relationship between back problems and the possible causes that give rise to them. Some authors (Vlaeyen et al., 2018) describe this problem as a real challenge for researchers and health professionals, due to the enormous variety of manifestations, possible causes, risk factors and consequences for quality of life. Although several studies establish incorrect sitting posture, sitting for long periods of time, incorrectly adjusted school furniture, school bags, lack of rest, a high Body Mass Index and time spent using electronic devices as risk factors for the appearance of back pain, other studies have found no relationship between these factors and back pain. One of the latter studies (Sainz de Baranda et al., 2020a), despite not relating the appearance of back pain to an inadequate sitting posture, does warn about the high number of students who do not sit properly in class and the possible harmful effects for a still developing spine which spends a large part of the day in the same position (Sainz de Baranda et al., 2020a; Minghelli, 2020a). Recall that, although adult height is reached between 15-17 years for girls and 17-19 years for boys (Carrascosa and Mesa, 2018), full bone maturity does not end until around 25 years of age (Cech and Martin, 1995).

Most of the articles analysed highlight that back ailments are more frequent as students get older and especially affects the female population. The moment of appearance is at very early ages, around 10 years of age (Miñana-Signes et al., 2021a), becoming more acute from 11-12 years of age (Sukartini et al., 2020) and several studies agree that that the probability that this condition persists into adulthood is very high (Dugan, 2018; Coenen et al., 2017). But it is not necessary to reach adulthood to assess the consequences of this problem. Back pain in school-age children is a growing public health problem, consuming health service resources and overloading the health system (Minghelli, 2020a; Garvick et al., 2019).

For all these reasons, prevention training programs should accompany the student throughout their academic life and not be limited to the temporal range corresponding only to their compulsory schooling. Even more so when a study (Jonsdottir et al., 2019) relates academic adherence as a risk factor for back pain. That is, the longer the time spent in the educational system, the greater the probability of suffering from back pain.

The large percentage of studies dedicated to the prevalence and causes of back pain in children, adolescents and young adults is striking, compared to the subject of study in the rest of the publications. Likewise, it is paradoxical that, in view of the devastating results on the incidence of back problems in the population analysed, the majority of these studies recommend the educational intervention of postural education content in the school environment, but there are very few articles. focused on this type of interventions.

On the other hand, several studies highlight the protective factor of physical activity, especially school Physical Education, against the problems caused by low back pain (González-Gálvez et al., 2021; Masiero et al., 2021; González-Gálvez et al., 2020; Schwertner et al., 2020; O'Sullivan et al., 2019; Hartvigsen et al., 2018). This fact shows the need to enhance the useful practice time in this area, as well as provide a greater weekly workload for this subject at all educational stages (Uddin et al., 2020), as recommended by the European Commission in the Eurydice Report (EACEA, 2013).

To the scarce literature on the implementation of postural education programs in the field of formal education, an additional limitation must be added: the characteristics of the samples analysed. Of the 11 articles found, 5 (45%) are studies based on samples of less than 50 students, which requires taking the data with caution before extrapolating the results, especially in those cases whose samples are made up of groups. -class already predefined by the educational centre and not random (Morales-Vallejo, 2009).

Regarding the size of the samples used, it should be noted that back pain prevalence studies were implemented in larger population groups. Most of the articles of this type include samples of more than 500 people and, within these, the majority were carried out in groups of over 1000 people, a figure not found in any of the other three types of research. On the opposite end are studies on intervention programs in postural education, with a much smaller sample size. In this case, most of the studies found were carried out with samples of less than 100 people. This fact can be explained by the characteristics of the research itself. Prevalence studies require larger samples to be representative. The cross-sectional nature and the use of an effective instrument, such as the self-administered questionnaire, in the majority of back pain incidence studies provides agility to the process and facilitates the management of larger samples that provide significance to the investigation.

On the other hand, the studies found on educational interventions in school environments, due to their mostly longitudinal nature, require maintaining groups under control throughout the duration of the study (weeks, months or years), before, during and after the intervention. In several of these studies, a combination of various research instruments (questionnaires, field tests, teaching materials, interviews, electronic devices, etc.). Smaller samples facilitate the management of this task without diminishing the significance of the results obtained.

Even so, the results of the intervention programs in postural education demonstrate the effectiveness and benefits obtained through the implementation of education programs for back health in the field of formal education. Improvement increases in programs of longer duration, weekly frequency, and practice time (Minghelli et al., 2021). Several studies have highlighted the low level of knowledge about back care that students have at the beginning of the intervention (Miñana-Signes, 2017; Miñana-Signes et al., 2019; Cabrera-González et al., 2020). This finding has been confirmed by other prevalence studies that obtained very low levels of general knowledge about back health (Kedra et al., 2019; Aparicio-Sarmiento et al., 2019).

Regarding the contents of the intervention programs in postural education, most of the analysed studies focused on both theoretical and practical aspects. The theory focused on anatomical and functional concepts of the back. Practice focused on learning correct postures in daily life situations (including the school environment) and the consequences of inappropriate postures. The postures included were both static and dynamic and those that most frequently appeared in these studies were: sitting (sitting alone on a chair/bench, at a desk/table, writing, working with a computer, watching TV, playing video games...); carrying a backpack (placing the backpack on the back, proper distribution of objects inside, maximum weight of the backpack...); lying down (lying, sleeping...); mobile phone use (writing a message); standing (static); managing objects (reaching for an elevated object, lifting a heavy or light object from the ground, carrying heavy objects and shopping bags...). Some studies also included physical exercises for strength and flexibility to improve student's physical condition and mitigated possible physical limitations when adopting the correct position.

The instruments used in this type of interventions were varied: mainly written questionnaires, practical performance tests and physical condition tests. The questionnaires were used to measure the level of knowledge about back health care, the prevalence of back pain and to record personal and sociodemographic data; The practical performance tests measured the ability/skill of each student implement proper postures in different situations of daily life; and the physical tests measured the student's level of physical condition, especially the strength, endurance and flexibility of the muscles involved in the posture.

The studies of research instruments' validation aimed to measure the reliability and applicability of 4 instruments that recorded information about back health knowledge. The instruments used in the 4 investigations were also questionnaires.

## **CONCLUSIONS**

Scientific literature on postural education programs shows the effectiveness of interventions in the educational field, but the literature is scarce compared to the numerous studies about prevalence of postural problems.

Scientific production is concentrated mainly in the last 2 years and comes mostly from European researchers. Spain and Brazil are the countries with the greatest scientific contribution to the topic of study.

The most common type of study is correlational and the predominant methodology is quantitative.

The scientific journals that contributed the most literature are those whose themes are directly linked to health.

Most of the articles were published by 4 or more authors and the researchers who most frequently appear as first authors are the Italian Beatriz Minghelli and the Spanish Vicente Miñana-Signes.

The sample size is considerably larger in studies on the prevalence of postural problems than in educational intervention programs in schools.

The contents of the postural education intervention programs focus on addressing postures present in daily life (and school) situations, which are summarized in sitting, standing, lying down, carrying a backpack, using the phone and moving objects.

The most commonly used instrument in the analysed articles is the questionnaire. The main variables to be measured were knowledge of back health, the presence of pain and personal data of the student evaluated.

Many articles warn about the high prevalence of back pain, especially low back pain and emphasize the preventive factor of physical activity and Physical Education in school, so giving this subject a greater curricular weight and reinforcing the contents of postural education would yield important health benefits.

The prevalence of back pain in children, adolescents and young adults, especially in women, is very high in all the analysed countries. This problem causes serious harm to the population. The onset age is before adolescence. It affects the female gender to a greater extent and there is a high probability that this condition will persist into adulthood, which makes it one of the most underestimated health problems.

For all these reasons, it is necessary to promote preventive and literacy training programs on back health care in formal education that involve the entire educational community.

## **AUTHOR CONTRIBUTIONS**

All authors have contributed significantly to the design of the project, selection of documents, reading and analysis of texts, as well as to the final writing of the manuscript.



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