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REVIEW PAPER

Physical activity monitoring in Portugal: looking for a surveillance system

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Abstract

In 2022, Portugal ranked among the 10 countries with the highest prevalence of insufficient physical activity (PA) levels, exceeding 50%. This study aimed to characterize epidemiological studies conducted in Portugal that assessed population PA and evaluate their quality based on the characteristics of a PA surveillance system (SS). Studies that analyzed data on PA, covering at least mainland Portugal, were selected and characterized. An original quality framework was developed as part of this study to assess whether the studies can be considered SS: 1) use a scientifically validated instrument; 2) repeated measurements; 3) assess age groups representing a lifespan; 4) sample representative of Portugal; 5) combine self-reported data with accelerometry; 6) assess PA contexts; 7) collect sedentary behavior data; 8) use the World Health Organization guidelines as a cut-off for sufficient PA; 9) interpretation of results based on sociodemographic variables; 10) accessibility and dissemination of results. Ten studies were characterized. When submitted to the framework, compliance with the characteristics ranged from 50% to 90%. A high number of studies assess PA levels in Portugal but employ different methodologies, leading to difficult-to-compare results. The lack of full compliance with the criteria emphasizes the limitations of monitoring. These findings highlight the need for the implementation of a unified SS in Portugal.

Keywords: noncommunicable diseases, surveillance system, Portugal, physical activity, epidemiology

Introduction

Physical inactivity is one of the main risk factor for noncommunicable diseases (NCDs) and premature mortality worldwide [1-3]. Nevertheless, there is still a preference for paying to cure or, at least, to manage diseases such as cardiovascular diseases, type 2 diabetes, cancer, and obesity rather than investing in prevention [1,4].

The most recent international estimates show that, in 2022, approximately 30% of the global adult population (≥18 years) exhibited insufficient levels of physical activity (PA), with Portugal ranking among the top 10 countries (out of 163) where the prevalence of this risk factor exceeded 50% [5]. The World Health Organization (WHO) estimates that between 2020 and 2030, around 500 million new cases of NCDs will occur globally [4]. These cases could be preventable if the prevalence of physical inactivity decreases [4].

In Portugal, 36% of the resident population aged between 25 and 74 years had high blood pressure in 2015 [6]. Regarding diabetes, 1.1 million Portuguese individuals aged between 20 and 79 years (14.1%) were living with the disease in 2021 [7]. In 2016, 20.8% of

the Portuguese population over the age of 18 was classified as obese [8], and the mortality rate associated with this condition in the same age group was 17% in 2019 [9]. This mortality rate is slightly higher than the European Union (EU) average, and the high prevalence of physical inactivity among adults and children in Portugal raises concerns about a possible future increase in obesity rates [9].

According to the WHO, adults (≥18 years old) are considered sufficiently active if they engage in at least 150 minutes per week of moderate-intensity aerobic PA [10]. If all individuals within this age group across the EU countries complied with the WHO recommendations, it is estimated that a total of 8 billion euros in purchasing power parity could be saved annually [11].

Regarding children and adolescents, global information concerning PA levels in children remains limited [12]. However, when examining data on children aged 6 to 9 years, the WHO European Childhood Obesity Surveillance Initiative (COSI) reported that, in its fifth round of data collection conducted between 2018 and 2022 across 45 countries, only 41% of children commuted to school actively (on foot, by bicycle, skating, or using other non-motorized means) [13]. Notably, in Portugal, which also participated in this study, this percentage fell sharply to 15.5% [13]. Moreover, data pertaining to adolescents aged 11 to 17 are particularly alarming if we consider that, in 2016, 81% of school-going adolescents worldwide did not meet the minimum recommendation of 60 minutes of daily moderate-to-vigorous PA [10,14]. This study by Guthold et al., funded by the WHO, also reveals that Portugal exceeded the global rate, reporting that 84.3% of adolescents aged 11 to 17 were insufficiently active in that same year [14].

Acknowledging physical inactivity as a major health issue of the 21st century does not undermine the relevance of other health-related concerns [15]. There is a clear need to reinforce among the population the importance of maintaining a healthy and balanced diet for physical well-being, to continuously improve smoking prevention and cessation programs, and to ensure access to advanced, evidence-based medical care that contributes to an ever-improving quality of life [15]. Experts are concerned that physical inactivity is often underestimated compared to other risk factors and is disregarded by many individuals within public health and clinical medicine [15,16]. Public health aims to prevent and control the incidence of disease within a given population through surveillance and multisectoral interventions at the governmental level [17,18]. Therefore, physical inactivity is a public health issue [1,15], as eliminating this risk factor would contribute to the control and reduction of NCDs [3,15], including mental health conditions such as depression and anxiety [2,10].

To prevent the increasing prevalence of NCDs – as well as the associated mortality rates – it is essential to implement effective governmental measures aimed at stabilizing and ultimately reducing these outcomes [4].

Consequently, the existence of efficient surveillance systems to monitor PA over time is key [1,19,20]. A health surveillance system is defined as "the ongoing systematic collection, analysis, and interpretation of health data essential for planning, implementing, and evaluating public health activities. Surveillance needs to be linked to timely dissemination of the data, so that effective action can be taken to prevent disease" [21]. We typically hear about health surveillance systems in the context of disease monitoring, yet both the European Commission (EC) and the WHO strongly recommend the inclusion of PA behavior monitoring within national health surveillance systems, not only in European countries but also worldwide [2,22,23].

To the best of our knowledge, and after a critical literature review, we identified no instrument specifically developed to evaluate the quality of studies examining PA patterns across the entire lifespan. Although Aubert et al. developed an assessment tool to evaluate the methodology of studies reporting PA levels, their scope was specifically children and adolescents aged 0 to 17 years [24].

Aim of the work

Our study aimed to identify and characterize epidemiological studies conducted in Portugal that assessed population PA and to evaluate their quality based on the fundamental characteristics of a PA surveillance system.

Methods

This critical review began with a literature search to identify potential epidemiological studies that assessed the PA of the Portuguese population. Public health surveillance systems are generally characterized by a governance structure in which national authorities retain overall leadership and coordination responsibilities [23,25,26]. Data collection, analysis, and dissemination are often shared with or delegated to academic institutions, research centers, and other stakeholders [25,26]. This distributed model reflects the complexity of surveillance systems and the need for collaboration across multiple institutional actors, ensuring ethical and transparent oversight of these systems [25-27]. In this context, major scientific databases such as PubMed, Scopus, and Web of Science were excluded from this critical review, as the aim

was to identify institutional and nationally coordinated PA monitoring outputs. Instead, the search focused on institutional websites of governmental and academic organizations involved in PA monitoring in Portugal.

The literature search was conducted until February 1st, 2026, with no chronological restrictions on study publication dates or time-frame filters applied. The websites of national governmental and academic organizations relevant to PA promotion in Portugal and globally were searched, namely: *Direção-Geral da Educação* (DGE, Directorate-General for Education), *Direção-Geral da Saúde* (DGS, Directorate-General of Health), *Direção-Geral de Estatísticas da Educação e Ciência* (DGEEC, Directorate-General for Education and Science Statistics), *Escola Nacional de Saúde Pública* (ENSP, National School of Public Health), *Instituto de Saúde Pública da Universidade do Porto* (ISPUP, Institute of Public Health of the University of Porto), *Instituto Nacional de Estatística* (INE, National Institute of Statistics), *Instituto Nacional de Saúde Doutor Ricardo Jorge* (INSA, National Institute of Health Doutor Ricardo Jorge), *Instituto da Mobilidade e dos Transportes* (IMT, Institute for Mobility and Transport), e *Instituto Português do Desporto e Juventude* (IPDJ, Portuguese Institute of Sport and Youth).

The search process followed a targeted screening approach. Most of the selected institutions do not allow standardized keyword searches. Therefore, the identification of documents relied primarily on manual navigation through the official websites. For each institution, we consulted the sections typically used to publish surveillance reports, such as "publications (publicações)", "statistics (estatísticas)", "surveys (inquéritos)", "reports (relatórios)", "studies (estudos)", or "projects (projetos)". When websites included an internal search bar, broad terms related to the topic (e.g. "physical activity (atividade física)", "sport / sports activity (desporto / atividade desportiva)", "health (saúde)", "survey (inquérito)", "monitoring (monitorização)", "surveillance (vigilância)") were used.

Whenever necessary, we contacted the authors of the publications to clarify doubts about the characterization of the studies.

The inclusion criteria for study selection were: 1) analyzing population-level data on PA levels in Portugal within nationally or internationally coordinated institutional initiatives; 2) involving direct data collection on PA; and 3) covering, at least, mainland Portugal. Additionally, having analyzed data from the COVID-19 pandemic was defined as an exclusion criterion.

Subsequently, the identified studies were characterized based on their most recent edition and categorized by parameters under the following categories: 1) general information

and implementation characteristics; 2) data collection methods and instruments used; 3) results and dissemination of information; 4) characterization of the samples.

We developed a simplified evaluation framework for potential PA surveillance systems that is applicable to studies regardless of the specific age groups included, providing a versatile approach for population-wide assessment. A critical analysis was conducted by verifying compliance with ten essential characteristics comprising a PA surveillance system based on scientific literature. For each characteristic, we assigned a binary value, where "0" indicates the absence of the characteristic, and "1" indicates its presence. We summed these values ("1" or "0") for each study, representing the number of present characteristics. The number of present characteristics was converted into a percentage, providing a quantitative measure of the extent to which each study meets the fundamental criteria of a surveillance system.

Accordingly, we defined ten essential characteristics for a PA surveillance system based on the literature searched: 1) use a scientifically validated instrument [28]; 2) conduct repeated measurements over time [27,28]; 3) assess different age groups representing the entire life cycle (<5, 5-17, 18-64, 65+) [10,12,23]; 4) use a representative sample of the study population for the entire national territory (mainland Portugal, Azores, and Madeira) [28]; 5) combine self-reported data (questionnaires) with accelerometry data [1,28]; 6) assess the contexts of PA [1,23]; 7) collect data on sedentary behavior [28]; 8) use the WHO recommendations to define the cut-off between "sufficiently active" and "insufficiently active" individuals [10,12,28]; 9) analyze and interpret results based on the sample's sociodemographic variables [28]; 10) ensure open access to the results and communicate them to the public [27-29].

Literature review results

Twelve studies met the inclusion criteria: Barómetro da Atividade Física (Physical Activity Barometer) [30]; 2) Childhood Obesity Surveillance Initiative (COSI) [31]; 3) Eurobarometer – Sport and Physical Activity [32]; 4) European Health Interview Survey (EHIS) [33,34]; 5) Health Behavior in School-aged Children (HBSC) [35]; 6) Inquérito Alimentar Nacional e de Atividade Física (IAN-AF, National Food, Nutrition, and Physical Activity Survey) [36]; 7) Inquérito aos Hábitos Desportivos da População Escolar Portuguesa (Survey of Sports Habits of the Portuguese School Population) [37]; 8) Inquérito Nacional de Saúde (INS, National Health Survey) [33]; 9) Inquérito Nacional de Saúde com Exame Físico (INSEF, National Health Examination Survey) [38]; 10) REACT-COVID [39]; 11) SClínico – Cuidados de Saúde Primários (SClínico – Primary Health Care, PA assessment tool) [40,41];

12) Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva (National Physical Activity and Sports Monitoring System) [42].

Based on the exclusion criteria, the REACT-COVID [39] study was excluded from the analysis, as it was implemented solely during the COVID-19 pandemic.

Additionally, we noted that the INS [33] collects data for the EHIS [33,34] in Portugal. Since they use the same methodology, sample, data, and results, the EHIS and INS were treated as a single source of information, referred to as "INS/EHIS" in our study.

Following the application of inclusion and exclusion criteria, the ten studies were characterized and evaluated.

Authors of the *Barómetro da Atividade Física* [30] and *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42] studies were contacted to clarify uncertainties left unresolved by publications and websites.

A list of the identified studies and their main characteristics is presented in Tables 1, 2, 3, and 4. Table 5 compiles the ten defined ideal characteristics of a PA surveillance system and presents a simplified evaluation framework for the performance of such systems.

Table 1 shows that seven of the ten identified studies are national, and two of these (INS/EHIS [33] and INSEF [38]) use standardized international methodologies. The *Barómetro da Atividade Física* [30], IAN-AF [36], and INSEF [38] lack a consistent implementation schedule. However, although IAN-AF has produced two occasional reports [36], a new edition, overseen by DGS, was announced in December 2023 [43].

Table 2 shows that eight of the studies conducted personal interviews, either in person or by telephone. The studies used customized questionnaires developed specifically for them to assess population PA levels, except for INSEF [38], and three studies used the International Physical Activity Questionnaire [44] (IPAQ) (*Barómetro da Atividade Física* [30], Eurobarometer – Sport and Physical Activity [32], and IAN-AF [36]). Unlike the other studies, INSEF [38] and *SClínico – Cuidados de Saúde Primários* [40,41] did not assess the contexts in which individuals performed PA.

Of the ten studies, only IAN-AF [36], *SClínico – Cuidados de Saúde Primários* [40,41], and the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42] used the WHO recommendations to define the cut-off between "sufficiently active" and "insufficiently active" individuals. IAN-AF employed the IPAQ and simultaneously presented its results according to the WHO guidelines [36].

Five of the ten studies focused primarily on PA. The remaining addressed multiple sub-themes, including PA (COSI [31], HBSC [35], IAN-AF [36], INS/EHIS [33], and INSEF [38]).

Table 1. General information and implementation characteristics of the selected studies

Study name	Current governing institution	First year of implementation	Last year of implementation	Implementation frequency	Total number of reports	Notes
***Barómetro da Atividade Física* [30]**	DGS	2017	-	One-time	No report. Results available in REACT-COVID study report [39,45]	-
COSI [31]	WHO	2007	2021	Every 2-3 years	6	Currently includes 45 countries in the WHO European Region.
Eurobarometer – Sport and Physical Activity [32]	EC	2002	2022	Approximately every 4 years	5	Currently all 27 EU member states participate in this survey.
HBSC [35]	WHO	1982 (adopted by the WHO in 1983; Portugal joined in the 1997/98 school year)	2021	Every 4 years	7	Currently includes 51 countries from Europe, Central Asia, and Canada.
IAN-AF [36]	FMUP	1980 (data on PA was not collected that year)	2015/2016	Unknown (upcoming edition is currently being prepared)	2	The results obtained by IAN-AF in 2015 were later provided to the European study EU Menu. On December 4th, 2023, a public tender was launched by the DGS for the implementation of a new edition of the IAN-AF [41].
***Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37]**	DGEEC	2016	2021	Every 5 years	2	-
INS/EHIS [33,34]	INS: INSA EHIS: EC	1987	2019	1987-2014: no fixed periodicity; 2014-2019: every 5 years; post-2019: every 6 years	6	After 2014, the INS began collecting data for the European study EHIS. The first implementation of EHIS took place in 2006, with Portugal participating for the first time in 2014. The most recent edition, in 2019, was the first to be conducted across all 27 EU countries, as well as in Iceland, Norway, Serbia, Albania, and Türkiye – a total of 32 countries.

INSEF [38]	INSA	2015	2015	Unknown	1	Uses the EHES methodology, which is applied in 20 European countries.
***SClínico – Cuidados de Saúde Primários* [40,41]**	DGS	2017	2023	Continuous (individual clinical assessment)	No dedicated reports. Results in PNPAF annual reports (2020-2023 [40])	Evaluation tool used by doctors, nurses, and nutritionists in primary health care.
***Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42]**	IPDJ	2008	2018	Every 10 years	3	Between January 2018 and December 2019, in partnership with the EUPASMOS project.

Notes: COSI – Childhood Obesity Surveillance Initiative; DGEEC – *Direção-Geral de Estatísticas da Educação e Ciência*; DGS – *Direção-Geral da Saúde*; EC – European Commission; EHES – European Health Examination Survey; EHIS – European Health Interview Survey; EHIS-PAQ – European Health Interview Survey – Physical Activity Questionnaire; EU – European Union; EUPASMOS – European Union Physical Activity and Sport Monitoring System; FMUP – *Faculdade de Medicina da Universidade do Porto*; HBSC – Health Behaviour in School-aged Children study; IAN-AF – *Inquérito Alimentar Nacional e de Atividade Física*; INSA – *Instituto Nacional de Saúde Doutor Ricardo Jorge*; INSEF – *Inquérito Nacional de Saúde com Exame Físico*; INS – *Inquérito Nacional de Saúde*; IPDJ – *Instituto Português do Desporto e Juventude*; PNPAF – *Programa Nacional para a Promoção da Atividade Física*; WHO – the World Health Organization.

Table 2. Data collection methods and instruments used in the selected studies

Study name	Data collection method	Questionnaire used	Assesses PA contexts	Uses the WHO recommendations to define the cut-off between "sufficiently active" and "insufficiently active"	Study focused solely on PA	Anthropometric data collection	Accelerometry data collection
***Barómetro da Atividade Física* [30]**	Telephone interviews	To assess PA levels, IPAQ was used	Yes	No	Yes	No	No
COSI [31]	School questionnaire: online, completed by the COSI Portugal Regional Coordinators; Family questionnaire: online or paper, completed by the parents; Child questionnaire: direct interview with the child	3 questionnaires developed by COSI/WHO	Yes	No	No	Yes	No
Eurobarometer – Sport and Physical Activity [32]	Face-to-face interviews (in Portugal)	IPAQ	Yes	No	Yes	No	No
HBSC [35]	Online classroom questionnaire	WHO HBSC Questionnaire	Yes	No	No	Yes	No
IAN-AF [36]	Face-to-face interviews	3-84 years: questions on sedentary behaviors and regular participation in sports or scheduled leisure activities; 6-14 years: 4-day Physical Activity Diary; 15-84 years: IPAQ and ACI	Yes	Yes	No	Yes	Yes, to adjust the information for children. Accelerometers were placed on a subsample of 35 individuals aged between 6 and 14 years. Accelerometers were positioned on the

							dominant side of the waist, near the iliac crest.
***Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37]**	Online questionnaire completed with the support of a parent/guardian (1st cycle) or a designated teacher (2nd and 3rd cycles, and secondary education)	Developed questionnaire with 19 questions	Yes	No	Yes	No	No
INS/EHIS [33,34]	Face-to-face and web interviews	After 2014: EHIS-PAQ	Yes	No	No	Yes	No
INSEF [38]	Face-to-face interviews	Health interview surveys: towards international harmonization of methods and instruments; DANCOS; ECOS	No	No	No	Yes	No
***SClínico – Cuidados de Saúde Primários* [40,41]**	Face-to-face interviews	Formed by 3 questions: 1) number of days per week engaging in PA at least at a moderate intensity; 2) duration of PA on days it is practiced; 3) average time spent sitting per day	No	Yes	Yes	Yes	No
***Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42]**	Accelerometry and face-to-face interviews	Questions about the contexts of PA asked to a subsample of Portuguese adults	Yes	Yes	Yes	No	Yes, as an assessment method. Accelerometers were placed on all individuals and worn on the right side of the waist.

Notes: ACI – Activity Choice Index; COSI – Childhood Obesity Surveillance Initiative; DANCOS – Danish Health Interview survey; ECOS – *Em Casa Observamos Saúde*; EHIS – European Health Interview Survey; EHIS-PAQ – European Health Interview Survey – Physical Activity Questionnaire; HBSC – Health Behaviour in School-aged Children study; IAN-AF – *Inquérito Alimentar Nacional e de Atividade Física*; INS – *Inquérito Nacional de Saúde*; INSEF – *Inquérito Nacional de Saúde com Exame Físico*; IPAQ – International Physical Activity Questionnaire; PA – physical activity; WHO – the World Health Organization.

Only the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* used accelerometry as a data collection method [42]. IAN-AF also utilized accelerometers to validate information in a subsample of children aged 6 to 14 years [36].

Table 3 shows that, in addition to assessing PA, all the studies collected data on sedentary behavior. Regarding proportions of sufficiently active children/adolescents and adults, two of the ten studies provided results based on the WHO recommendations: IAN-AF [36] and the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42].

Table 4 shows that the study with the largest sample size was *SClínico – Cuidados de Saúde Primários* [40,41] due to the cumulative number of participants who completed at least one PA assessment between 2017 and 2023. The study with the smallest sample was the Eurobarometer – Sport and Physical Activity [32]. Regarding age range, the Eurobarometer – Sport and Physical Activity [32], INS/EHIS [33], and *SClínico – Cuidados de Saúde Primários* [40,41] included participants aged 15 and older, whereas the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42], the *Barómetro da Atividade Física* [30], and INSEF [38] recruited participants starting from ages 10, 18, and 25, respectively. Conversely, COSI [31], HBSC [35], and the *Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37] assessed only school-aged children and adolescents (ages 6 to 18). IAN-AF was the only study that included children, adolescents, young adults, adults, and older adults (ages 6 to 84) [36]. Moreover, four of the studies did not impose upper age limits (Eurobarometer – Sport and Physical Activity [32] , INS/EHIS [33], *SClínico – Cuidados de Saúde Primários* [40,41], and the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42]).

Table 3. Results and dissemination of information in the selected studies

Study name	Components of PA assessed		Proportion of sufficiently active children/adolescents (latest report)	Proportion of sufficiently active adults (latest report)	Latest results publicly available	Public dissemination of the results of the last edition
	PA	Sedentary behavior				
***Barómetro da Atividade Física* [30]**	Yes	Yes	-	-	No dedicated report. Data from REACT-COVID study and a conference abstract [30,39,45]	Digital media (social networks, websites, etc.)
COSI [31]	Yes	Yes	-	-	Only in report [31,46]; no scientific article since 4th edition [47]	Digital media
Eurobarometer – Sport and Physical Activity [32]	Yes	Yes	-	-	In report [32] and scientific article [48]	Digital media
HBSC [35]	Yes	Yes	-	-	In report [35,49] and scientific article [50]	Digital and traditional media (television, newspapers, radio, etc.)
IAN-AF [36]	Yes	Yes	6-14 years old: 57.5% 6-9 years old: 59.3% 10-14 years old: 56.5%	15-84 years old: 27.1% 15-21 years old: 35.6% 22-64 years old: 27.3% 65-84 years old: 21.8%	In report [36] and scientific articles [51,52]	Digital and traditional media
***Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37]**	Yes	Yes	-	-	In report [37]	Digital media
INS/EHIS [33,34]	Yes	Yes	-	-	The EHIS study does not have a report compiling data from all countries. Each country released its own report. However, the report from the most recent edition of the INS has not yet been made available. Only a summary on the INE portal [33]. Scientific article only on methodology. Although it does not correspond to the most recent report, the same methodology was applied [53].	Digital media
INSEF [38]	Yes	Yes	-	-	In report [38] and scientific article [54]	Digital media

***SClínico – Cuidados de Saúde Primários* [40,41]**	Yes	Yes	-	-	In PNPAF 2023 report [40]. Scientific article only on methodology [41]	Digital and traditional media
***Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42]**	Yes	Yes	10-14 years old: 15.2%	Younger adults: 15.4% Adults: 71.2% Older adults: 30.6%	In a scientific article, the first and latest editions were compared [42]. However, it is not freely available. Results from the 2018 edition can be accessed for free through reports on the impact of the COVID-19 pandemic on PA in 2020 [55] and 2021 [56].	Digital media

Notes: COSI – Childhood Obesity Surveillance Initiative; EHIS – European Health Interview Survey; HBSC – Health Behaviour in School-aged Children study; IAN-AF – *Inquérito Alimentar Nacional e de Atividade Física*; INE – *Instituto Nacional de Estatística*; INS – *Inquérito Nacional de Saúde*; INSEF – *Inquérito Nacional de Saúde com Exame Físico*; PA – physical activity; PNPAF – *Programa Nacional para a Promoção da Atividade Física*.

Table 4. Characterization of the samples of the selected studies

Study name	Sample size (latest report)	Age group	Sociodemographic variables collected	Geographic coverage	Sample randomization	Representative sample of the study population	Representative sample of the study population for the national territory (mainland Portugal, Azores, and Madeira)	Notes
***Barómetro da Atividade Física* [30]**	1 084	18-65 years old	Age, gender, geographical location	Mainland Portugal and Autonomous Regions of Azores and Madeira	Randomized	Yes	Yes	A probabilistic sampling method with age and gender quotas was used, ensuring representativeness of results for the study population based on these variables.
COSI [31]	6 205	6-8 years old	Socioeconomic factors, geographical location, health status, gender, age, nationality, parents' education level, parents' occupational category	Mainland Portugal and Autonomous Regions of Azores and Madeira	Non-Randomized	Yes	Yes	-
Eurobarometer – Sport and Physical Activity [32]	1 006	15+ years old	Age, gender, geographical location, education level, occupational category	Mainland Portugal	Randomized	Yes	No	-
HBSC [35]	5 809	11, 13 and 15 years old	Age, gender, geographical location, socioeconomic factors	Mainland Portugal	Non-Randomized	Yes	No	-
IAN-AF [36]	6553 (742 only completed first interview; 5,811	The study included a sample with ages ranging from 3	Age, gender, geographical location, education level	Mainland Portugal and Autonomous Regions of Azores and Madeira	Randomized	Yes	Yes	-

	completed both)	months to 84 years old. For PA, data were collected from individuals aged 6 to 84 years old						
***Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37]**	85 224	6-18 years old	Age, gender, place of birth, geographical location, education level, school year, parents' education level	Mainland Portugal	Randomization not mentioned in latest edition	Yes	No	-
INS/EHIS [33,34]	14 617	15+ years old	Socioeconomic factors, geographical location, gender, age, education level, occupational category	Mainland Portugal until 2005; from 2005 onward includes Azores and Madeira	Randomized	Yes	Yes, starting from 2005	-
INSEF [38]	4 911	25-74 years old	Age, gender, geographical location, socioeconomic factors, occupational category, education level	Mainland Portugal and Autonomous Regions of Azores and Madeira	Randomized	Yes	Yes	-
***SClínico – Cuidados de Saúde Primários* [40,41]**	232 557 (cumulative value from 2017 to 2023)	15+ years old	Age, gender, geographical location	Mainland Portugal	Non-Randomized	No	No	-
Sistema Nacional de Vigilância e Monitorização da Atividade	6 369	10+ years old	Age, gender, geographical location, education level	Mainland Portugal	Non-Randomized	Yes	No	Data analyses were weighted by gender, age, and region to ensure representativeness

***Física e Desportiva* [42]**								for the Portuguese population regarding these sociodemographic variables.

Notes: COSI – Childhood Obesity Surveillance Initiative; EHIS – European Health Interview Survey; HBSC – Health Behaviour in School-aged Children study; IAN-AF – *Inquérito Alimentar Nacional e de Atividade Física*; INS – *Inquérito Nacional de Saúde*; INSEF – *Inquérito Nacional de Saúde com Exame Físico*; PA – physical activity.

All the studies collected sociodemographic variables such as age, gender, and geographic location. Two of the ten also gathered clinical variables, such as health conditions (COSI [31] and INS/EHIS [33]).

Five of the samples were randomly selected (*Barómetro da Atividade Física* [30], Eurobarometer – Sport and Physical Activity [32], IAN-AF [36], INS/EHIS [33], and INSEF [38]). Samples from nine studies were representative of the target population, or data analyses were weighted to ensure representativeness. The *SClínico – Cuidados de Saúde Primários* [40,41] sample was not population-representative, as it is a tool designed solely for individual clinical assessment, thus data weighting was unnecessary.

Regarding representativeness across the entire national territory, five studies (Eurobarometer – Sport and Physical Activity [32], HBSC [35], *Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37], *SClínico – Cuidados de Saúde Primários* [40,41], and the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42]) were not representative of the Portuguese population, as they did not include the Autonomous Regions of the Azores and Madeira.

Table 5 shows that studies with the lowest percentage of compliance with the defined characteristics were the *Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37] and INSEF [38], meeting 50%. Four of the ten studies met 60% of the characteristics. COSI [31], INS/EHIS [33], and the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42] met 70% of the defined characteristics. Lastly, IAN-AF achieved 90% [36].

Table 5. Evaluation of the selected studies as PA surveillance systems

Study name	Use a scientifically validated instrument	Perform repeated measurements over time	Assess different age groups representing the entire life cycle (<5, 5-17, 18-64, 65+)	Use a representative sample of the study population for the entire national territory (Mainland Portugal, Azores and Madeira)	Combine self-reported data (questionnaires) with accelerometry data	Assess the contexts of PA	Collect data on sedentary behavior	Use the WHO recommendations to define the cut-off between "sufficiently active" and "insufficiently active"	Analyze and interpret results according to the sociodemographic variables of the sample	Ensure open access to the results and disseminate them to the general public	Total	Percentage of compliance with the characteristics
***Barómetro da Atividade Física* [30]**	1	0	0	1	0	1	1	0	1	1	6	**60%**
COSI [31]	1	1	0	1	0	1	1	0	1	1	7	**70%**
Eurobarometer – Sport and Physical Activity [32]	1	1	0	0	0	1	1	0	1	1	6	**60%**
HBSC [35]	1	1	0	0	0	1	1	0	1	1	6	**60%**
IAN-AF [36]	1	1*	0	1	1	1	1	1	1	1	9	**90%**
***Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37]**	0	1	0	0	0	1	1	0	1	1	5	**50%**
INS/EHIS [33,34]	1	1	0	1	0	1	1	0	1	1	7	**70%**
INSEF [38]	1	0	0	1	0	0	1	0	1	1	5	**50%**
SClínico – Cuidados de Saúde	1	1	0	0	0	0	1	1	1	1	6	**60%**

***Primários* [40,41]**												
***Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42]**	1	1	0	0	0	1	1	1	1	1	7	**70%**

Notes: *Although the third wave of data collection for the IAN-AF has not yet been conducted, a public tender was issued in December 2023 to carry it out [43]. COSI – Childhood Obesity Surveillance Initiative; EHIS – European Health Interview Survey; HBSC – Health Behaviour in School-aged Children study; IAN-AF – *Inquérito Alimentar Nacional e de Atividade Física*; INS – *Inquérito Nacional de Saúde*; INSEF – *Inquérito Nacional de Saúde com Exame Físico*; PA – physical activity; WHO – the World Health Organization.

Discussion of the review results

We gathered information on ten epidemiological studies that collected and analyzed data on PA levels of the Portuguese population using methodologies developed either nationally or internationally. While studies employing international methodologies allow for cross-country comparisons, those with national methodologies can account for cultural context, which is an advantage for designing effective policies tailored to the Portuguese population [1].

We found a high number of studies in Portugal assessing PA levels, often in similar contexts. However, these studies employed different samples and methodologies, leading to inconsistent and difficult-to-compare results. For instance, three of the ten studies were conducted in school settings but used distinct samples and data collection methods [31,35,37]. However, this issue is also observed in other countries and even across Europe. Previous studies that conducted inventories of PA surveillance systems have found the same problem: few efforts are being made to establish harmonized surveillance processes either at the national [57], or international levels [1,57], which would facilitate comparability. These findings suggest that a PA surveillance systems should be based on clear governance structures, ideally with national coordination, ensuring methodological harmonization and consistency over time [23,25,26]. Such an approach is essential to enable comparability across different survey waves, as well as with data from other countries, thereby contributing to more robust and sustainable monitoring.

In addition to the quality assessment developed in this study, to the best of our knowledge, there is only one published study in the literature available that has conducted a quality framework to assess studies assessing PA used in the surveillance of PA [24].Aubert et al. [24] evaluated eight children and adolescent PA surveillance initiatives, with one of the study's objectives being to identify methodological limitations, surveillance, and research gaps. To achieve this, they verified compliance with 20 criteria, assigning the following scores: 0 = not met; 1 = partially met; and 2 = fully met [24]. Beginning the comparison between both assessment tools by looking at the scoring approach, we believed that an unambiguous method better suited the purpose of our study. For example, in our study, we could also have distinguished between studies with samples partially representative of the Portuguese population (because they included only mainland residents) and those with samples representative of the entire national territory including the Azores and Madeira. However, two reasons justified not making this distinction: (1) if we clearly define that a surveillance system must have a given characteristic, it cannot be considered a good surveillance system if it only partially meets it; (2) since our final objective was to convert the number of characteristics

present into a percentage to obtain a quantitative measure of the extent to which each study meets the fundamental criteria of a surveillance system, in our view, it would be unfair for a study that partially meets all ten characteristics and a study that fully meets five characteristics to receive the same score.

Regarding the comparison between the ten criteria we selected, and the twenty criteria proposed by Aubert et al. [24], there are three criteria in common between our study and theirs: use a scientifically validated instrument; use a representative sample of the study population for the entire national territory; analyze and interpret results based on the sample's sociodemographic variables. Aubert et al. [24] defined four separate criteria for each sociodemographic variable they considered important for studies to assess, while we defined a single criterion encompassing all sociodemographic variables. Another similar criterion can be found in both quality assessment tools: we used the criterion "use the WHO recommendations to define the cut-off between 'sufficiently active' and 'insufficiently active' individuals", whereas Aubert et al. [24] used the criterion "clear description of the definition of physically active/inactive used". We decided to accept only the WHO recommendations for PA as the cut-off to define the threshold between sufficiently and insufficiently active individuals, since these were developed based on strong scientific evidence and with the endorsement of several experts in the field [10,28]. This brings credibility to the criterion used, making it relevant for the design of public health interventions and policies.

The remaining six criteria we defined differ from the remaining thirteen proposed by Aubert et al. [24], mainly for two reasons: 1) the tool developed by Aubert et al. was designed to assess the methodological quality of epidemiological studies, placing particular emphasis on how each criterion is described and implemented. In our case, the objective is different: we sought to assess whether studies conducted in Portugal did, or did not, possess the characteristics defined as essential for a surveillance system. Therefore, we focused on identifying essential requirements rather than evaluating methodological reporting. 2) Aubert et al. evaluated only international PA surveillance initiatives conducted in children and adolescents, which led to the inclusion of criteria very specific to that age group. In contrast, the tool developed in our study was designed to assess epidemiological studies that analyzed the entire Portuguese population, which requires a different and more comprehensive set of criteria.

Regarding the percentage of compliance with the fundamental characteristics of a PA surveillance system, all ten studies met at least 50% of the criteria for a high-quality system. The study most aligned with the definition of a surveillance system was IAN-AF [36], as long

as it establishes a regular implementation periodicity in the future, as planned. However, none fulfilled all essential characteristics. The absence of full compliance with the established criteria highlights the limitations in national monitoring and indicates that Portugal lacks a unified system capable of producing harmonized data. Consequently, it is hard to get a clear picture of the actual PA levels of the Portuguese population and to track their evolution consistently and systematically.

On a positive note, all studies collect data on sedentary behavior, analyze and interpret results according to the sociodemographic variables of the sample, and ensure open access to the results and disseminate them to the general public.

The *Inquérito aos Hábitos Desportivos da População Escolar Portuguesa* [37] was the only study we identified that, as far as could be determined, did not use a scientifically validated instrument, compromising the reliability of the collected data [28].

Two of the ten studies did not conduct repeated measurements over time [30,38].Systematic data collection enables the detection of trends and patterns over time, sometimes allowing the anticipation of behaviors or changes. Since systematic data collection is one of the defining characteristics of a surveillance system [21], these studies cannot be considered as such. Although it is widely accepted that surveillance systems should conduct regular measurements over time, there is, to the best of our knowledge, no universally defined "ideal" time interval [1,23,27,28]. The optimal interval may vary depending on the objectives of the surveillance system. Nevertheless, the WHO provides useful guidance regarding PA surveillance. In "Global Action Plan on Physical Activity 2018-2030", it establishes that the Global Status Report should update and report global comparable estimates on the prevalence of physical inactivity every five years (2021, 2026, and 2031) [23]. Additionally, when analyzing the studies with known periodicity included in this critical review, the average data collection interval is approximately 4.7 years, which is consistent with this international recommendation. Based on these elements, a monitoring cycle of approximately five years appears to be an appropriate frequency to ensure the ability to detect trends and patterns over time, while maintaining the operational feasibility of PA surveillance systems.

None of the studies assessed all age groups representing a full life cycle. However, IAN-AF assessed PA in individuals aged 6 to 84 years, covering most of the life cycle, and this was the study that included the greatest number of age groups in its analysis [36]. Additionally, only four of the ten analyzed studies did not establish an upper age limit [32,33,40-42]. Considering that in 2022, 24% of the Portuguese population was aged 65 years or older [58], it is crucial not to set an upper age limit, ensuring broad inclusion of this age group [1]. Furthermore, in 2022,

only 12.9% of the Portuguese population was aged 0 to 14 years [58]. This suggests that the existence of three studies conducted exclusively in school settings may be questioned, given the relatively low representativeness of this age group.

Five of the ten studies did not use a representative sample of the study population for the entire national territory [32,35,37,40-42].

Only IAN-AF combined self-reported data with accelerometry, although accelerometry was conducted only in a subsample of children aged 6 to 14 years [36]. Since it also used the WHO recommendations as the cut-off between "sufficiently active" and "insufficiently active", it appears to have reported the most representative results regarding PA levels in the Portuguese population. *SClínico – Cuidados de Saúde Primários* [40,41], although it used the WHO recommendations to define the cut-off between "sufficiently active" and "insufficiently active", does not present data on the proportions of sufficiently active individuals per year. Another study that reported results using the WHO recommendations as a cut-off was the *Sistema Nacional de Vigilância e Monitorização da Atividade Física e Desportiva* [42] However, this study used accelerometry as the data collection method. The current WHO PA guidelines, however, are based mainly on systematic reviews of studies using self-reported data obtained through questionnaires, collecting qualitative and quantitative information on PA [10,19,29]. Therefore, they should not be directly compared with estimates obtained exclusively through accelerometry due to variations in the translation of acceleration signals into PA behavior information [19]. It is known that self-reported measures are susceptible to recall and response bias [59,60]. However, although accelerometry may underestimate certain activities such as strength training activities and activities performed by limbs where no sensor is present [19], it also captures total movement, due to increased precision and accuracy [59]. Consequently, differences in prevalence estimates between the two methods partly reflect differences in what is being measured [19]. This limits the direct comparability between self-reported data and accelerometer-derived data when using the same cut-off point (e.g. 150 minutes per week of moderate-to-vigorous PA). Universal guidelines based on human movement data, particularly accelerometry, have not yet been established [10,19,29]. Therefore, accelerometry should be used only as a complement to the data obtained through self-report [1].

Regarding the assessment of PA contexts, INSEF [38] and *SClínico – Cuidados de Saúde Primários* [40,41] were the only studies that did not perform this.

This study can contribute to the development of policies grounded in clear, concrete, and evidence-based data. Additionally, it may guide the analyzed studies in refining

methodologies and addressing identified gaps, aligning closer to the definition of a PA surveillance system.

Despite the relevance of the findings, the present study is subject to certain limitations. Although an exhaustive search of online databases was conducted, it is technically possible that some studies were not identified and included, which may have resulted in selection bias. Furthermore, the method employed to evaluate the quality of the studies was a simplified proposal that had not undergone formal scientific validation by a consortium of subject-matter experts. This represents a methodological limitation, as the tool's sensitivity and reliability have not been formally verified. However, all parameters included in the framework were derived from recommendations by international organizations, such as the WHO, and evidence-based findings from literature [1,10,12,23,28,29] ensuring alignment with recognized standards. To mitigate potential bias, all the authors participated in the development and review of the framework, and the final version reflects a collective consensus. Nevertheless, as the tool lacks external validation, its reliability remains formally unverified, which may introduce a degree of subjectivity into the scoring process. Consequently, the classification of these studies should be interpreted as an informed preliminary assessment rather than a definitive diagnostic. We also acknowledge that while the selected criteria were sufficient to characterize a surveillance system based on literature, a more exhaustive set of parameters might have resulted in different quality scores. We emphasize the need for a formally validated instrument in future evaluations to standardize these assessments.

Conclusions

We conclude that the implementation of a single surveillance system in Portugal that systematically collects, analyzes, interprets, and disseminates data on PA is urgently needed. This would enable continuous evaluation of the impact of existing health promotion policies. Additionally, considering that Portugal is one among the ten countries in which more than 50% of the population has insufficient levels of PA [5], a unified surveillance system would serve as a foundation for the implementation of new actions aimed at preventing diseases whose main risk factors include physical inactivity and sedentary behavior.

For future research, it would be important to develop and subject to scientific validation a method for assessing studies that collect data on PA, whether building upon the simplified proposal presented herein or through the adoption of a new approach. A scientifically validated evaluation tool would not only strengthen national surveillance but could also be applied to

studies of other countries or even applied to studies in the European context. This would contribute to the standardization of methodologies, facilitating study comparability.

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