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Use of quasi-experimental studies to evaluate causal effects of public health interventions in Portugal: a scoping review

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Abstract

Background Quasi-experimental designs are a valid option to assess causal effects of public health interventions when randomized studies are unfeasible, but not widely used in Portugal. We identified and reviewed characteristics of studies employing quasi-experimental designs to evaluate causal effects of public health interventions in Portugal.

Methods PubMed, Scopus, Web of Science and CINHAL were searched, alongside grey literature, reference mining and contact of authors of eligible studies. We extracted information on the intervention assessed, study design, outcomes assessed, statistical analysis and reporting guidelines.

Results We identified 1143 studies; 25 were eligible. Studies assessed interventions in various areas, mainly healthcare services (28.0%), drugs/tobacco consumption policy (20.0%), and COVID-19 related restrictions (20.0%). Studies employed interrupted time series (56.0%) and difference-in-differences designs (44.0%). Analyses utilised regression-based models, namely linear (48.0%), negative binominal (20.0%) and logistic (12.0%). Studies analysed 53 outcomes, with two outcomes per study on average. No reporting guidelines were mentioned.

Conclusions There is a limited number of studies using quasi-experimental designs to estimate the causal effects of public health interventions in Portugal, mainly interrupted time series and difference-in-differences. Training in this area might promote the adequate use and dissemination of quasi-experimental studies.

Keywords Causal effects, Public health, Quasi-experimental studies

Background

Evaluation of causal effects of interventions, i.e. assess whether a given intervention has produced a change in a health outcome distribution, has traditionally relied on randomized controlled trials. In this experimental approach, an intervention and control group exist, and the intervention is randomly allocated. If well succeeded, randomization ensures that both observed and non-observed confounders are accounted for [1]. However, evaluating causal effects of public health interventions using traditional randomized controlled trials might not be feasible due to ethical, economic, political and even design challenges [1, 2]. In other instances, we might

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be interested in assessing real-world effects rather than those observed in trial contexts. Alternative designs have been adapted from other fields, under a broad category of "quasi-experimental" designs, and deemed as a valid option to overcome such challenges. Such designs have been termed inconsistently, thus challenging description and discussion around them [1, 3]. For the purposes of this study, we will consider quasi-experimental studies as those where the causal effects of an intervention are assessed by exploiting the exogenous variation (i.e. outside the system of causal relationships under study) in the intervention assignment [3, 4]. By exploiting an exogenous variation, researchers are able to identify adequate counterfactuals, i.e. groups or periods that represent what would have happened in the absence of intervention. If properly conducted this category of studies is deemed as "good as if random" [1].

Quasi-experimental studies can exploit variation in time (interrupted time series – ITS, difference-in-differences – DID, synthetic controls) or other variables (e.g. regression discontinuity, instrumental variables) [5]. An in-depth revision of these methods is beyond the scope of this work and can be found in various references (e.g. Basu et al. [5] and Reeves et al. [3]). Previous studies in Portugal have employed such studies to assess effects of health policy, vaccines or public health measures during the COVID-19 pandemic [6–8]. These studies have mainly employed interrupted time series designs and overall, such designs are still not widely used in Portugal. Given their potential as a way to assess effects of public health interventions, knowing their use will support the development of this research area in the country. We thus aimed to identify and characterise studies employing quasi-experimental designs to evaluate causal effects of public health interventions in Portugal.

Methods

We identified and reviewed characteristics of studies employing quasi-experimental designs to evaluate causal effects of public health interventions in Portugal using the principles of a scoping review to ensure a structured approach.

Protocol and registration

Study protocol included the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR) [9] and is registered in the Open Science Framework [10, 11].

Inclusion and exclusion criteria

We included studies assessing the causal effects of one or more public health interventions in Portugal (either at the national or regional level) using a quasi-experimental study design. For the purposes of this review, quasi-experimental studies were defined as abovementioned and focused on difference-in-differences, interrupted time series, synthetic controls, instrumental variables, regression discontinuity or any variation of these designs (e.g. controlled interrupted time series) [5]. As previously pointed out authors might not label studies according to these classifications [3]. Whenever there was not a clearly stated design or the description offered doubts regarding the study design conducted, we referred to the checklist proposed by Reeves et al. to catalogue studies under a specific study design [3]. We did not impose any restriction on the type of public health interventions as a way to perform a more comprehensive approach. Instead, we deemed any study assessing a health-related outcome as potentially eligible, given the other criteria were fulfilled.

Commentaries, letters to the editor, or simulation studies were excluded.

Whenever studies did not provided enough information to assess eligibility we contacted the authors, with a subsequent follow-up email. If authors did not reply we excluded those studies.

Information sources

PubMed, Scopus, Web of Science and CINHAL were searched combining free text and controlled vocabulary terms. Searches were supplemented by reference mining and contact of authors of eligible studies. Grey literature were identified through: (i) screening of tables of contents of *Boletim Epidemiológico Observações*, a non-indexed scientific publication run by the National Health Institute Doctor Ricardo Jorge [12], and (ii) national repository of national PhD and MSc programmes theses (*Repositórios Científicos de Acesso Aberto de Portugal*, RCAAP). Following an initial list of works to be included, we contacted authors of eligible studies, provided the list of already identified works and inquired about further ongoing or completed studies that fulfilled the inclusion criteria.

Search strategy

We developed an initial search strategy for PubMed and adapted it to other databases. Systematic review accelerator provided an automated adaption, which was then reviewed by the authors [13]. Given the breadth of potential interventions, we identify papers based on two concepts: quasi-experimental studies and Portugal. Searches employed are presented in Annex A (Supplementary material). Searches were initially run on the 16th November 2022 and updated on 15th July 2024. As RCAAP offers limited search tools, we searched for doctoral and master theses using five search combinations: "public health" AND "interrupted time series"; "public health" AND "difference-in-differences", "public health"

AND "synthetic controls"; "public health" AND "regression discontinuity"; "public health" AND "instrumental variables". Searches were performed on 12th July 2024.

Selection of sources of evidence

For results from literature databases two authors screened title and abstract, followed by double-screening of full text (AL, IK and AM). For reference mining and grey literature, and given the breadth of studies in these information sources screening was initially based on title, followed by abstract and full text. Only full text level was double-screened (AL and AM). We used systematic review accelerator [13] and Rayyan to assist deduplication, and Rayyan to assist the screening process from literature databases [14]. Deduplication of sources from reference mining and grey literature was performed manually, at the abstract screening level, using the list of eligible studies from each source. Whenever we identified different publications on the same study, we included the peer-reviewed one or the most complete if all or none were peer–reviewed.

Data charting process and data items

We developed a standardised extraction form including information on: intervention assessed (description of the intervention assessed, geographical area of implementation and assessment, time period covered), study characteristics (study design, statistical analysis approach, data source, measures of effect), variables considered (outcomes, confounding, stratification and others), sensitivity analysis, research team (considering affiliations and described as national/international, academia, research institutes or policy-makers) and reporting guidelines employed. The form was piloted with two papers and revised accordingly. Extraction was performed at the analysis level, i.e. described for each relevant measure of effect estimated in the paper.

Critical appraisal of individual sources of evidence

Several tools have been proposed to assess risk of bias of quasi-experimental studies. However, they have limited ability to assess all sources of bias in the designs considered for this review [15]. In the absence of a unifying critical appraisal checklist we used the Target Trial Framework for Natural Experiment Studies proposed by de Vocht et al. (Supplementary material, Annex B) [16]. We analysed each eligible paper and assess whether "Theorising the causal contrast" questions have been addressed, answering the questions as yes, partially, no or unclear. Yes was selected when the paper fully addressed the question under examination, partially when authors mentioned information that covered the aspect under examination in an incomplete manner, no when there was a clear indication the aspect under assessment had not been considered, unclear when there was no sufficient information. Quality assessment was performed by one author (AL or IK) and verified by a second one (IK or AL). Results of this assessment were presented as a heatmap, coloured according to the answers. Quality assessment was conducted at the paper level.

Synthesis of results

Results were synthesised narratively, with descriptive information on areas and characteristics of assessed public health interventions, study design and statistical analysis employed. Whenever possible, descriptions were categorised and absolute and relative frequencies were reported. As a paper could include more than one analysis, we synthesised results both at the paper and analysis level, according to the applicable level.

Results

Selection of sources of evidence

We identified 1021 results from four databases, 58 from grey literature, 64 from reference mining and none from experts contact. Following screening, 25 studies fulfilled the eligibility criteria (Fig. 1).

Results synthesis

The main characteristics of studies included are presented in Table 1.

Interventions assessed covered diverse areas, including healthcare services policies ($n=7$, 28.0%), tobacco and drugs consumption-related policies ($n=5$, 20.0%), COVID-19 related restrictions ($n=5$, 20.0%), drugs including vaccines ($n=3$, 12.0%), food-related policies ($n=2$, 8.0%), among others ($n=3$, 12.0%). Intervention implementation ranged from 1996 to 2022. Yet, all studies were published from 2014 onwards, particularly in 2020 ($n=7$, 28.0%). Study design was mainly ITS ($n=14$, 56.0%), followed by DID ($n=11$, 44.0%). One study employed in-sample forecast event modelling in addition to ITS. Authors utilised a variety of data sources, with administrative hospital data (*Base de Dados Morbilidade Hospitalar*, BDMH) being used most often ($n=7$, 28.0%). Studies assessed 53 outcomes, yielding an average of two outcomes per study. These were mainly treated as continuous variables ($n=26$, 49.1%), available on yearly basis ($n=27$, 50.9%). Statistical analyses (at the study level) were mainly based on regression methods, in particular linear regression ($n=12$, 48.0%), followed by negative binomial ($n=5$, 20.0%), and logistic regression models ($n=3$, 12.0%). Most studies did not include any sensitivity analysis ($n=14$, 56.0%). Studies were mainly conducted by national academics researchers ($n=7$, 28.0%), followed by teams comprising both academics and professionals from research institutes and healthcare units ($n=5$, 20.0%), with international academics or

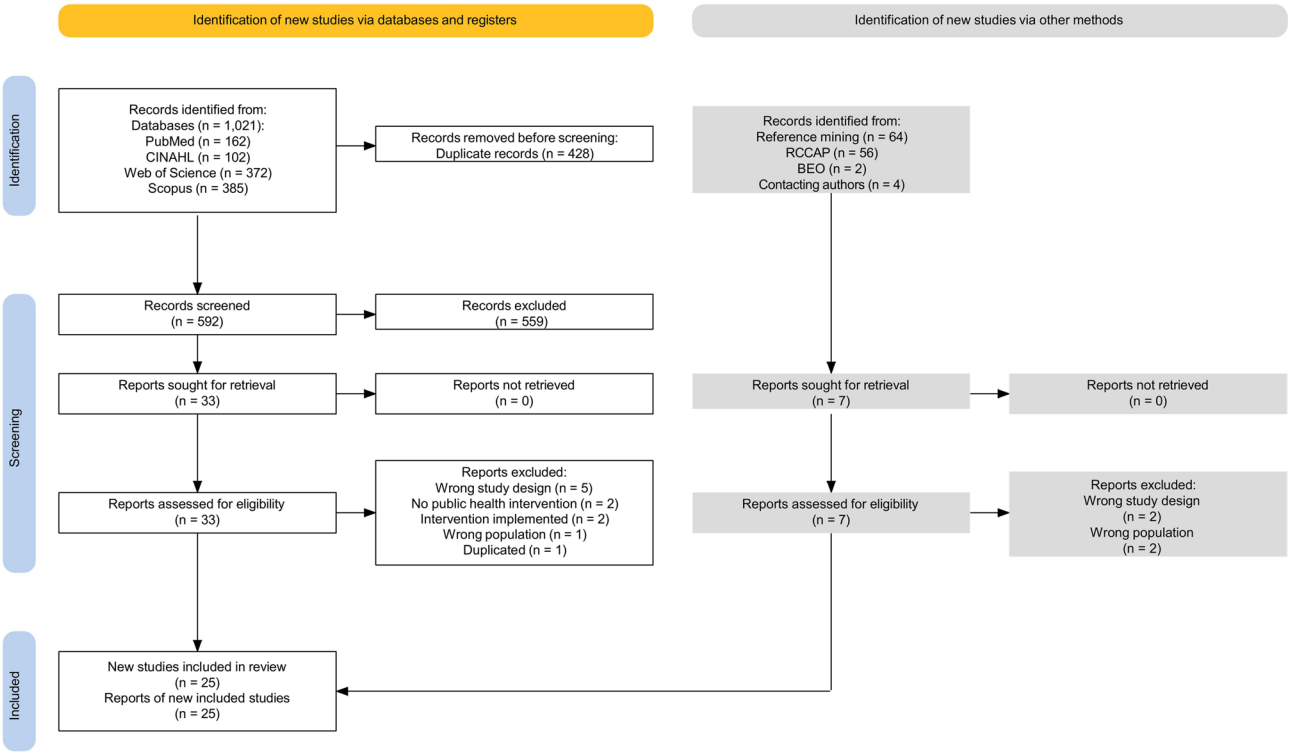

Fig. 1 PRISMA flow diagram (generated from Haddway et al. [17]). RCCAP - *Repositórios Científicos de Acesso Aberto de Portugal* [Theses repository], BEO – *Boletim Epidemiológico Observações* [National Health Institute scientific publication]. Alt text: A flow diagram indicating the number of results at each stage of the screening process

other combinations in the remaining ones. No specific reporting guidelines were mentioned in the manuscripts. The 25 studies yielded 105 analyses. All studies reported a relative or absolute measure of effect. Most included adjustments for confounders ($n = 79$, 75.2%) and stratified results ($n = 65$, 61.9%).

Critical appraisal

Results of the quality assessment conducted are presented in Fig. 2. Studies mostly described the intervention assessed and which counterfactual were considered (Q1 to Q6 and Q8). Principles of causal inference were less often employed. In particular, the plausibility of as-if randomization of the assignment has not been discussed (Q9) nor the causal contrasts formalized and defined as average-treatment effects (Q15 and Q16). Questions related to stability of intervention and remaining in the same groups were often deemed non-applicable due to the nature of interventions assessed (Q7, Q10 and Q12). Parallel trends, follow-up periods and outcomes of interest have mostly been described when applicable (Q11, Q13 and Q14). Authors mostly provide relative and/or absolute measures of effect (Q18) but did not often estimate the number events averted (Q19). Statistical Analysis Plan (SAP) were not mentioned in the manuscripts (Q17) and replication was often not fully possible (20).

Discussion

Main findings of this study

Our review identified studies that assessed the effect of public health interventions in Portugal employing quasi-experimental designs.

Our results indicate that the use of quasi-experimental designs for evaluating public health interventions has increased over time at the national level and that interrupted time series and difference-in-differences designs were the most frequently used to assess causal effects.

The growing application of quasi-experimental designs has also been consistently reported at the international level in health policy evaluations, pharmacoepidemiology and health service research, and linked mostly to significant digital transformation in the healthcare sector and the increased availability for research of routinely collected administrative data [41–45]. Although the choice of a particular study design depends on the specific research question, the nature of the intervention, and data availability, several studies support the more frequent use of ITS and DID compared to other quasi-experimental designs [46–49] for evaluation of health policies and public health interventions. This trend may be related to a growing dissemination of practical tutorials and step-by-step guides for these study designs in epidemiology and public health journals, making them more

Table 1 Characteristics of studies included according to intervention assessed, study design, data analysis, research team and reporting guidelines used

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Abreu, 2017 [18]	Smoking legislation (ban on closed spaces)	2008	ITS	BDMH	Continuous	• Monthly crude event rate of ACS hospital admissions; • Monthly proportion of patients with ACS diagnosis that were current smokers	Segmented multiple linear regression model with first order autoregressive structure of the residuals	Monthly	Linear	Yes
Abreu, 2018 [19]	Salt reduction strategy	2010	ITS	National Registry Acute Coronary Syndrome	Continuous	• Monthly proportion of ACS patients presenting with previously diagnosed HBP; • Monthly rate of ACS admissions; • Monthly rate of stroke admissions	Segmented multiple linear regression model with first order autoregressive structure of the residuals	Monthly	Linear	Yes
Abreu, 2019 [6]	Fast-track system to coronary units (*Via verde coronária*)	2007	ITS	BDMH	Continuous	Monthly ACS case-fatality rate	Segmented multiple linear regression model with first order autoregressive structure of the residuals	Monthly	Linear	Yes
Abreu, 2020 [20]	Fast-track system to coronary Units (*Via verde coronária*)	2007	ITS	BDMH	Continuous	Monthly ACS case-fatality rate	Segmented multiple linear regression analysis with first order autoregressive structure of the residuals	Monthly	Linear	Yes

Table 1 (continued)

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Adam, 2017 [21]	Cannabis-related policies	1994–2004	DID	European Monitoring Centre for Drugs and Drug Addiction data	Continuous	• Annual Prevalence of cannabis consumption; • Treatment uptake (new clients with primary cannabis use per reporting treatment unit)	Linear regression with robust standard errors	Yearly	Linear	NA
Aiken, 2021 [22]	COVID-19 lockdown	2020	ITS	Women on Web	Count	Daily number of requests made to Women on Web (abortion)	Generalised linear model (Poisson or negative binomial)	Daily	Poisson or negative binomial*	No
Bellerba, 2024 [23]	School re-opening (COVID-19)	2022	ITS	Surveillance data on laboratory confirmed COVID-19 cases	Continuous	Daily case reproduction number (Rc)	Generalized least-squares regression models with an Autoregressive-Moving–Average structure	Daily	Linear	No

Table 1 (continued)

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Benedetti, 2021 [24]	Cannabis-related policies	2001–2013	DID	European school Survey Project on Alcohol and other Drugs	Continuous	• Prevalence of easy access to cannabis; • Past-year prevalence of all cannabis users; • Past-year prevalence of experimental cannabis use; • Past-year prevalence of non-frequent cannabis users; • Past-year prevalence of cannabis frequent users	Linear regression	Yearly	Linear	No

Table 1 (continued)

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Dimitrovová, 2020 [25]	Creation of Family Health Units	2006–2015	DID	BDMH, BI-CSP, Statistics Portugal	Continuous	• Annual hospitalisation rate for overall ACSC per 1000 adult inhabitants; • Annual hospitalisation rate for circulatory-related ACSC per 1000 adult inhabitants; • Annual hospitalisation rate for diabetes-related ACSC per 1000 adult inhabitants; • Annual hospitalisation rate for respiratory-related ACSC per 1000 adult inhabitants; • Annual hospitalisation rate for urinary-related ACSC per 1000 adult inhabitants	Linear regression with fixed effects cluster-robust standard errors	Yearly	Linear	NA
Fernandes, 2020 [26]	Vertical integration (local health units)	1999–2012	DID	BDMH	Binary	Occurrence of readmission within a 30-day time frame following an index admission	Logistic regression	NA	Logistic	NA

Table 1 (continued)

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Gonçalves, 2020 [27]	Soda tax	2016–2018	DID	Quantities of beverages purchased (data from a retailer)	Continuous	Drinks consumption per quarter	Linear models with multi–way fixed effects, with log-transformed outcome and clustered standard errors	Quarterly	Linear	NA
Hoffman, 2019 [28]	Smoking legislation (WHO Framework Convention on Tobacco Control)	2003	ITS; In-sample forecast event modelling	Database from a reported reference	Continuous	• Year-over-year change in cigarette consumption per capita for adults aged 15 years and older; • Cigarette consumption per capita for adults aged 15 years and older	Linear regression	Yearly	Linear	Yes
Kislaya, 2019 [7]	Introduction of PCV7 and PCV13	2001–2002 and 2010	ITS	BDMH, Statistics Portugal, Portuguese Sentinel Practice Network	Count	Monthly number of pneumococcal pneumonia hospitalisations in adults aged 65 years or more	Poisson regression models with correction for overdispersion	Yearly	Poisson	Yes
Leitão, 2020 [29]**	Heat waves contingency plans implementation	2004	DID	All-cause mortality database (Statistics Portugal), Daily temperatures database IPMA	Count	Daily number of all-cause deaths	Generalized linear model, quasi-Poisson with identity link	Daily	Quasi-Poisson	NA
Lopes, 2017 [30]	Vertical integration (local health units) of 6 primary care services/hospitals	2004–2013	DID	BDMH	Binary	30-day unplanned readmission	Logistic regression	NA	Logistic	NA

Table 1 (continued)

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Pereira, 2020 [31]	Tolls on SCUTs highway	2010–2011	DID	Statistics Portugal, National Employment Agency (IEFP - *Instituto de Emprego e Formação Profissional*); Marktest; Department for Geographical Planning (DGOTDU – *Direção Geral Do Ordenamento do Território*); Ggovernment Agency for Road Security (ANSR – Autoridade Nacional de Segurança Rodoviária)	Count	• Total number of accidents per year; • Number of accidents on highways per year; • Number of accidents on national roads per year; • Number of accidents on other types of roads per year; • Total number of accident victims per year; • Number of accident victims on highways per year; • Number of accident victims on national roads per year; • Number of accident victims on other types of roads per year; • Number of minor injuries per year; • Number of serious injuries per year; • Number of deaths per year	Negative binomial regression with robust standard errors	Yearly	Negative binomial	NA

Table 1 (continued)

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Pinto, 2018 a [32]	Regulatory measures on nimesulide	2007–2008	ITS	Pharmacy reimbursement records NHS, Google trends, Portuguese Sentinel Practice Network	Continuous	Defined daily doses of nimesulide dispensed per month	Segmented (linear) regression	Monthly	Linear	Unclear
Pinto, 2018 b [33]	Regulatory measures on trimetazidine	2012–2013	ITS	Pharmacy reimbursement records NHS, Google trends	Continuous	Number of trimetazidine-containing products defined daily doses dispensed per month	Segmented (linear) regression corrected for 1 st order autocorrelated residuals using Prais–Winsten estimator	Monthly	Linear	Unclear
Ramos, 2016 [34]	Increase in NHS co-payments	2012	DID	ED Manchester Triage data from three North of Portugal hospitals	Binary	Severity of ED visits	Logistic regression with clustered standard errors for administrative region of residence	None	Logistic	NA
Ricoca Peixoto, 2020 [35]	COVID-19 lockdown	2020	ITS***	Surveillance data on COVID-19 occupied hospital beds and beds in intensive care	Count	• Daily number of COVID-19 occupied ICU beds; • Daily number of COVID-19 occupied hospital beds; • Daily number of new COVID-19 cases; • Daily number of COVID-19 associated deaths	Exponential smoothing	Daily	ARIMA and exponential smoothing	Yes

Table 1 (continued)

Study	Intervention	Year of intervention	Study design	Data source	Outcome	Outcome	Data analysis	Periodicity	Model type	Autocorrelation
Sánchez, 2017 [36]	Change in the limits of work hours	1996	DID	European Community Household Panel	Continuous	Self-assessed health	Random-effect ordered probit model with clustered standard errors	None	Probit	NA
Sassano, 2024 [37]	Smoking legislation (ban on closed spaces)	2008	ITS	Database from a reported reference	Count	• Cigarette consumption; • Acute myocardial infarction mortality	Negative binomial regression	Yearly	Negative binomial	Yes
Torres, 2022 [38]	COVID-19 tiered restrictions system	2020	ITS	Surveillance data on laboratory confirmed COVID-19 cases, Statistics Portugal population	Count	COVID-19 incidence rate	Negative binomial regression model with first-order autoregressive term	Daily	Negative binomial	Yes
Torres, 2023 [39]	Lifting of the mask mandate	2022	ITS	Surveillance data on laboratory confirmed COVID-19 cases, Statistics Portugal population	Count	• Daily number of COVID-19 cases; • Daily number of COVID-19 deaths	Negative binomial regression	Daily	Negative binomial	No
Vaz, 2016 [40]	Increase in NHS co-payments	2012	DID	ED visits Manchester Triage data from three North of Portugal hospitals	Count	Weekly number of ED visits	Negative binomial regression with robust standard errors	Weekly	Negative binomial	NA

ACS Acute Coronary Syndrome, *ACSC* Ambulatory Care Sensitive Conditions, *BDMHBase de dados Morbilidade Hospitalar* (hospital administrative data), *BI-CSPBilhete Identidade Cuidados Saúde Primários* (Primary Health Care Identity Card), *DID* Difference-in-differences, *ED* Emergency Department, *ICU* Intensive Care Unit, *ITS* Interrupted Time Series, *NHS* National Health Service, *PCV7* 7-valent Pneumococcal Conjugate Vaccine, *PCV13* 13-valent Pneumococcal Conjugate Vaccine, *WHO* World Health Organization

*Unclear which one was used

**Identified from grey literature

*** In this study the statistical analysis did not formally considered an ITS. However, as it compares the number of observed events to an expected number based on a counterfactual and in the absence of a better classification we deemed it as an ITS

known and more available to the public health research community [42, 45, 46, 50–55].

The potential role of such design during COVID-19 pandemic [56] might have further contributed to authors considering its use. Regression discontinuity, synthetic controls and other designs remain to be explored as well as variations of employed designs, such as controlled interrupted time series. According to previous authors this might be related to less experience in the use of these designs [46].

Interventions assessed covered a wide range of areas, reflecting the breadth of intervention in public health. Health services related policy has been the area with more interest which might be related to the application of these methods traditionally in economics fields and more interest in these questions from researchers with

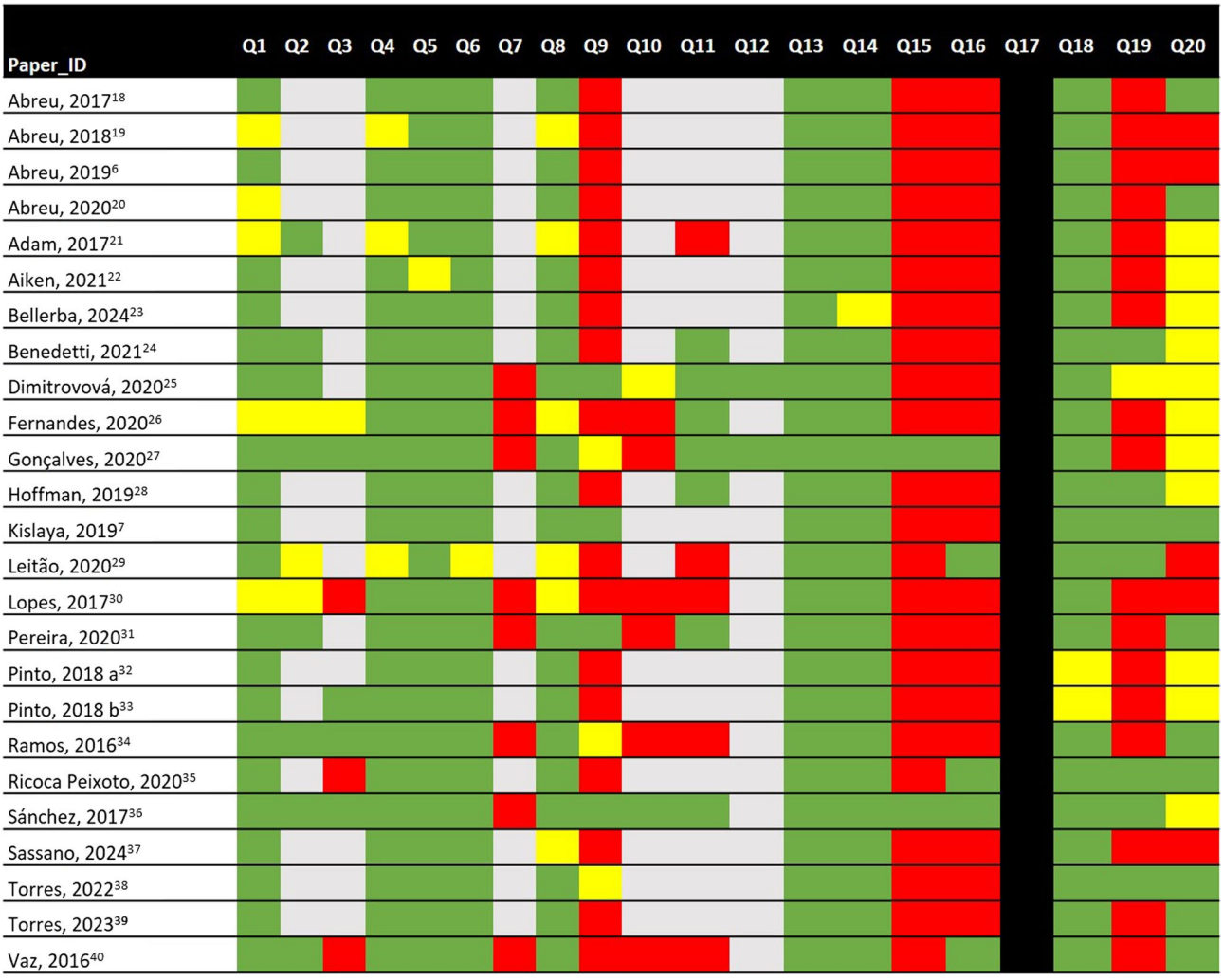

Fig. 2 Critical appraisal of included papers. Full list of questions is provided in Annex B (Supplementary material). Colours represent answers to these questions: Green – Yes, Yellow – Partially, Red – No, Grey – Not applicable, Black – Unclear. Alt text: A heat map providing quality assessment for each included paper

background in such fields [1]. Assessment of COVID-19-related restrictions has also led to interest in these design. It should be noted that during screening we identified various other studies that have employed interrupted time series to assess the effect of the "pandemic" on a variety of health outcomes [57–59]. However, these studies were excluded as they were not assessing a specific public health intervention. Yet, this reinforces the interest in quasi-experimental designs at national level.

Interventions assessed also highlighted the areas of further exploring. Surprisingly, vaccine-related policies have only been assessed in one study. Population-level impacts of immunisation programs are often of interest to guide vaccine-related policies [60]. In addition to interrupted time series, difference-in-differences and synthetic controls have also been proposed specifically in this context [44]. Environmental-related questions, such as pollution reduction interventions, and cancer screening programmes [61] are other avenues of further research using quasi-experiments. Thus, causal effects questions of various public health interventions and policy in Portugal remain to be addressed using quasi-experimental designs.

Authors have used a number of data sources according to the research question under study. Administrative hospital data has been one of the most commonly used, as previously pointed out [46]. Yet, it is possible to harness the potential of other existing electronic health records, such as primary care (SClinico), vaccination (VACINAS), mortality (SICO), medication prescription registry (PEM) or routinely collected environmental-related data, in accordance with areas for further examination. Portugal places a strong emphasis on digital transformation and supports open data science initiatives. Since 2018, the country has allocated specific funding for collaborations between research institutions and public

administration, aiming to improve the utilisation of routinely collected administrative data in research. Recent work in the country analysing electronic health records might pave the way for a more widespread use of these data.

Our results indicate, that statistical analysis is also an area for improvement. In fact, and in particular for studies using interrupted time series, there was often no mention of important aspects, such as verification of the models assumptions and autocorrelation. This finding is in accordance with a previous scoping reviews specifically looking at interrupted time series and is an additional gaps to consider in further studies [45, 46, 53].

Our quality assessment underlined additional areas in critical need for improvement. While information regarding the intervention, outcome and measures of effect was overall reported, causal inference-related questions, and information required for reproducibility were less often reported, none of the papers mentioned statistical analysis plan or made data analysis code publicly available. Authors might not have formally approached their studies from a causal inference standpoint. Nevertheless, due to the nature of the questions addressed in eligible studies, we believe this would be a natural framework to consider. Further training in this area would benefit from combining principles in both quasi-experimental studies and causal inference.

What is already known on this topic

Quasi-experimental designs are a valid alternative to randomized controlled trials when randomisation is not feasible. The interest in these designs has increased in the last decades, particularly for ITS. Yet, such methods are not widely known and gaps on its application have been identified. Its application to assess public health interventions in Portugal has not been assessed.

What this study adds

Our study provides information on specific quasi-experimental employed to assess causal effects of public health information in Portugal. It highlights that work in this field has focused on the use of the most well-known designs (ITS and DID) and there is a myriad of interventions still to be assessed using such approach. Furthermore, we identified critical gaps in the quality of the works conducted, which can guide methodologists and those involved in training on areas in need of development. Our work can be applied beyond our country as an example of areas to improve, as the aspects mentioned are likely generalizable to settings with limited expertise in public health and epidemiology.

As quasi-experimental study designs continue to evolve [46, 50] it is of utmost importance to ensure that those employing these methods are familiar with current state of art. Tutorial papers [51, 54], training, and discussions around these methods in scientific fora are ways of contributing to an adequate use of quasi-experimental study designs to assess causal effects of public health interventions.

Limitations of this study

Our study also presents some limitations. We have employed a comprehensive search, including both literature databases and grey literature. While we might have missed some studies, given the breadth of our search it is unlikely that we have missed a number of studies capable of introducing substantial changes in our results. Additionally, we have not restrict a definition of public health interventions and decided to include all studies assessing interventions effects on health-related outcomes. This led to the inclusion of two papers that are not deemed to be public health interventions, namely introduction of highway tolls and change in limits of working hours. Yet, these constitute a minority of our results and it is also relevant to have an assessment of interventions in other areas as potentially impacting health. Finally, the tool we selected to assess the quality of papers did not discriminate according to study design characteristics. While this approach was meant to employ a single tool to assess studies, it might have led to miss specific aspects of each particular design.

While we hypothesise that there is a limited use of quasi-experimental studies to assess the causal effects of public health interventions our results might also indicate there is a paucity of studies focusing on the estimation of causal effects employing other study designs. If that is the case the issue is even broader and addressing it requires work of both researchers and decision-makers to ensure conduction of studies in this area.

In conclusion, there is a limited number of studies using quasi-experimental designs to estimate causal effects of public health interventions in Portugal. Interrupted time series and difference-in-differences designs are mainly used. Training in this area might promote the adequate use and dissemination of quasi-experimental studies.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12874-025-02701-3.

Supplementary Material 1.

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Authors' contributions
AL design the study, conducted the search, screened and extracted information from eligible studies, draft and reviewed the manuscript. IK contributed to the design of the study, screening and information extraction, and critically reviewed the manuscript. AM contributed to the design of the study, screening, and critically reviewed the manuscript. BN, PA and CMD contributed to the design of the study, and critically reviewed the manuscript. All authors approved the final version of the manuscript.

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Data availability
The data underlying this article are available in the article and in its online supplementary material.

Declarations

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Not applicable.

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Not applicable.

Competing interests
The authors declare no competing interests.

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