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Parental childhood vaccine hesitancy and the National Vaccination Programme, in Portugal

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Dissertation presented to fulfill the requirements necessary to obtain the master's degree in Public Health, carried out under the scientific guidance of Professor Ana Rita Goes and Doctor Patrícia Soares

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Abstract

Introduction: Vaccine hesitancy is increasing in the European Union, despite the invaluable contribution of vaccination for populations' health. This study aims to estimate the proportion of parental childhood vaccine hesitancy (PCVH) and to determine vaccination and Portuguese National Vaccination Programme (NVP) associated factors.

Methods: A cross-sectional study was performed using an anonymous online questionnaire directed to parents of children aged 17 months old or less living in Portugal. An exploratory factor analysis was performed and five dimensions were created: 1. vaccine confidence; 2. access to enough/reliable information about vaccines; 3. access to NVP; 4. vaccination schedule; 5. trust in healthcare professionals' information about vaccines. Its scores were extracted, and used in crude and adjusted logistic regression analyses, to estimate its association with PCVH.

Results: PCVH proportion was estimated at 1.8% (95% Confidence Interval – 95% CI: 1.0%-3.0%; n=790). Vaccine confidence (adjusted Odds Ratio – aOR=0.29, 95% CI: 0.14-0.54), vaccination schedule (aOR=0.31, 95% CI: 0.15-0.58) and trust in information about vaccines provided by health professionals (aOR=0.30, 95% CI: 0.16-0.53) were protective dimensions of PCVH.

Discussion and Conclusion: The low proportion of PCVH observed is coherent with the high immunisation coverage in Portugal. High confidence in vaccines is closely linked to low vaccine hesitancy. Aspects of the vaccination schedule, such as the number of simultaneous vaccines, contribute to parents' decision on child's vaccination. Health professionals play an important role in addressing this problem. Strategies focused on these dimensions may contribute to PCVH reduction.

Key words: parental childhood vaccine hesitancy; vaccine confidence; vaccination schedule; trust in health professionals

Resumo

Introdução: A hesitação vacinal está a aumentar na União Europeia, apesar do inestimável contributo da vacinação para a saúde da população. Este estudo pretende estimar a proporção de hesitação vacinal em pais de crianças (HVPC) e determinar que fatores da vacinação e do Programa Nacional de Vacinação (PNV) lhe estão associados.

Métodos: Foi realizado um estudo transversal utilizando um questionário online anonimizado, dirigido a pais de crianças até aos 17 meses, residentes em Portugal. Foi efetuada uma análise fatorial exploratória e criadas cinco dimensões: 1. confiança nas vacinas; 2. acesso a informação suficiente/confiável sobre vacinas; 3. acesso ao PNV; 4. esquema vacinal; 5. confiança na informação sobre vacinas dada pelos profissionais de saúde. Os *scores* foram extraídos e utilizados em regressões brutas e ajustadas, para estimar a sua associação com a HVPC.

Resultados: A proporção de HVPC foi de 1,8% (IC 95%: 1,0%-3,0%; n=790). Confiança nas vacinas (ORa=0,29, IC 95%: 0,14-0,54), esquema vacinal (ORa=0,31, IC 95%: 0,15-0,58) e confiança na informação sobre vacinas dada pelos profissionais de saúde (ORa=0,30, IC 95%: 0,16-0,53) foram dimensões protetoras de HVPC.

Discussão e Conclusão: A reduzida proporção de HVPC obtida é coerente com a elevada cobertura vacinal em Portugal. Uma elevada confiança nas vacinas está fortemente relacionada com reduzida hesitação vacinal. Aspetos do esquema vacinal, como o número de vacinas em simultâneo, contribuem para a decisão dos pais em vacinar as crianças. Os profissionais de saúde desempenham um papel importante neste âmbito. Estratégias focadas nestas dimensões podem contribuir para reduzir a HVPC.

Palavras-chave: hesitação vacinal em pais de crianças; confiança nas vacinas; esquema vacinal; confiança nos profissionais de saúde

Table of contents

List of figures

List of tables

List of abbreviations and acronyms

α	Cronbach's alpha
aOR	Adjusted Odds Ratio
CI	Confidence Interval
EU	European Union
EU-SILC	European Union Statistics on Income and Living Conditions
HVPC	Hesitação Vacinal em Pais de Crianças
IC	Intervalo de Confiança
KMO	Kaiser-Meyer-Olkin
NVP	National Vaccination Programme
OR	Odds Ratio
ORa	Odds Ratio Ajustado
PCVH	Parental Childhood Vaccine Hesitancy
PNV	Programa Nacional de Vacinação
REDCap	Research Electronic Data Capture
SAGE	Strategic Advisory Group of Experts
SDGs	Sustainable Development Goals
WHO	World Health Organization

Introduction to the study

Vaccination is one of the Public Health interventions that has contributed the most to population's health (1). It plays an important role in 14 of the 17 United Nations' Sustainable Development Goals (SDGs), being critical to the accomplishment of SDG3: 'ensure healthy lives and promote well-being for all at all ages' (2,3). Vaccination may directly contribute to four targets of SDG3 (2): target 3.2, reducing 'preventable deaths of newborns and children under 5 years of age'; target 3.3, contributing to the end of the 'epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases'; target 3.8, through universal health coverage, including vaccines for all; target 3.b, related to the 'research and development of vaccines and medicines'.

Recent challenges faced in Europe, such as the COVID-19 pandemic and the war in Ukraine, threaten childhood immunisation programmes and contribute to an increasing risk of outbreaks of vaccine-preventable diseases (3–5). Increased vaccine hesitancy also contributes to decreasing immunisation coverage rates in European Union (EU) countries (4,6,7). Vaccine hesitancy exists in all EU countries (8) and, similar to immunisation coverage, does vary within different regions of the same country (6). Although Portugal is among the EU countries with the highest immunisation coverage (4,9), in Alentejo and Algarve the immunisation coverage rates were less than 95% in five different vaccines in children of two years old (10). The slight decrease in vaccine confidence observed in Portugal between 2018 and 2022 (11) may be a warning sign, predictive of more reduced vaccination coverage in the future. Monitoring vaccine hesitancy is important (12) but information regarding this issue is still scarce in Portugal. Assessing its determinants is crucial to better understand which strategies may be effective in tackling this issue (7,13).

In Portugal, the National Vaccination Programme (NVP) is one of the pillars of the national health service. It was implemented in 1965 and is coordinated by the Directorate-General of Health (14). Vaccination against 12 of the 13 diseases included is initiated during the first year of life (14). Vaccination in this early stage of life prevents severe diseases and should not be postponed (14). Several factors may influence parents' decision to vaccinate a child (15). A deeper comprehension of how they affect parental childhood vaccine hesitancy in Portugal will contribute to finding strategies to alleviate this problem.

The aim of this study is to estimate the proportion of vaccine hesitancy in the first 12 months of life in Portugal, and to assess which vaccination and National Vaccination Programme factors are associated with vaccine hesitancy. The target population are parents of children aged 17 months old or less living in Portugal.

Draft of the submitted scientific article

Introduction

Vaccination is one of the public health interventions that has most improved population's health (1) and childhood immunisation programmes substantially contribute to disease prevention (4). Europe has recently been facing challenges, such as the COVID-19 pandemic and the war in Ukraine, threatening immunisation programmes, preventing countries from attaining the 95% immunisation coverage threshold (3–5). Between 2010 and 2021, vaccination coverage in the European Union (EU) has highly fluctuated, increasing the risk of outbreaks of vaccine-preventable diseases (4). In the EU, vaccination rates are associated with vaccine hesitancy levels; countries with high levels of hesitancy observe lower immunisation coverage (6). Vaccine hesitancy adds to the challenges that hold back childhood immunisation programmes (4).

According to the World Health Organization's (WHO) Strategic Advisory Group of Experts (SAGE) on immunisation, 'vaccine hesitancy refers to delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is complex and context specific, varying across time, place and vaccines. It is influenced by factors such as complacency, convenience and confidence.' (13). Vaccine hesitancy exists in all EU countries (8) and, similar to immunisation coverage, does vary within different regions of the same country (6). Although Portugal is among the EU countries with the highest immunisation coverage (4,9), there are regions where coverage rates are behind the 95% threshold in 2-year-old children (10). The slight decrease in vaccine confidence observed in Portugal between 2018 and 2022 (11) may be a warning sign, predictive of a more reduced vaccination coverage in the future.

EU countries have different policies and approaches to vaccination (7). Vaccination programmes in the EU are adapted to the specificities of each country (7). The Portuguese National Vaccination Programme (NVP) includes free-of-charge vaccines against 13 diseases (14). Vaccination against 12 of these 13 diseases is initiated during the first year of life (14). Vaccination during this period should not be delayed as it prevents severe diseases in children (4,14).

As in Portugal, in Italy there is a national immunisation programme managed by the national health service (7). Concern about the increasing vaccine hesitancy and in response to the decreasing vaccination coverage rates between 2014 and 2016, due to increasing vaccine hesitancy, in 2017, the Italian Parliament approved a law to make 10 vaccines mandatory for children until 16 years to attend school (7,16). With this measure, coverage rates of the national programme's mandatory and recommended vaccines

have increased (7,16). Strategies like this one are extreme and should be temporary (7), and its effectiveness is not proven in all contexts (16).

Understanding national vaccination programmes' factors related to vaccine hesitancy may contribute to tackling this problem differently. Only giving information to the population about the importance of vaccination and the harmful effect of vaccine hesitancy, as occurred in France for a long time, may not be enough (7). This country also increased from three to 11 childhood compulsory vaccines, in 2017 (7,16). To increase vaccination acceptance, action should be taken towards the core categories of vaccine hesitancy: complacency (related to low perceived risk of vaccine-preventable diseases), convenience (which includes accessibility and quality of vaccination services) and confidence (which includes trust in vaccines safety and efficacy, health services and professionals) (7,13).

To better comprehend the complex phenomenon of vaccine hesitancy it is crucial to consider its determinants (13). In this context, the SAGE Working Group on Vaccine Hesitancy developed a matrix dividing factors in three categories: i) contextual influences; ii) individual and group influences; and iii) vaccine or vaccination-specific issues (13). These determinants are also valid in what concerns parental childhood vaccine hesitancy (15). Regarding ii) individual and social group influences, past experiences with health services (15,17), confidence on vaccines' safety and efficacy (15,18–22), and seeing immunisation as a social norm (15) may influence the decision to vaccinate the child. Other important factors may be parent's knowledge (15) and access to information about vaccines (18,20,21,23,24), and risk perception about vaccines and vaccine-preventable diseases (15,17,21–23,25,26), in particular, concerns about the unprepared immune system (22,25,26). The iii) vaccine or vaccination-specific issues include the vaccination schedule (15,19–24,26), its specific aspects such as the number of simultaneous vaccines (22,25,26), and its changes (e.g. the introduction of a new vaccine) (15,22,26); the accessibility of vaccination services (15,24), and trust in healthcare professionals (15,17,20–25,27).

Monitoring vaccine hesitancy is important (12) but information regarding this issue is still scarce in Portugal. A study performed in 18 European countries reported that Portuguese parents of children aged 1-4 years old were the least hesitant (9% self-reported vaccine hesitancy) and the most confident in vaccines (85%) (28). Other studies conducted in Portugal reported a vaccine refusal of 3.6% (18) and of 5.4% (29) in children until 12 and 16 years old, respectively. Neither of these studies used a representative sample of the population nor was specifically directed to parents of children in the first months of life (18,28,29). Believing that vaccines have low effectiveness and the lack of

information regarding vaccination were factors associated with the intention to not vaccinate the children (18). A deeper comprehension of parental childhood vaccine hesitancy factors in Portugal will contribute to understand which strategies may be effective in tackling this problem.

Aim of the study

The aim of this study is to estimate the proportion of vaccine hesitancy in the first 12 months of life in Portugal, and to assess which factors related to vaccination and the National Vaccination Programme (NVP) are associated with vaccine hesitancy. Most NVP vaccines are recommended for children during the first year of life (14). After the vaccines of 12 months, only at 18 months are more vaccines recommended (14). Taking this into consideration, the target population are parents of children aged 17 months old or less living in Portugal.

Methods

Study design

We performed a cross-sectional study. Data was collected through an anonymous online questionnaire, between the 8th May and 3rd July 2023, using the Research Electronic Data Capture (REDCap) platform. The study informative sheet and the consent form were made available at the beginning of the questionnaire. Only after consenting to participate in the study, would the respondents be able to begin answering the questionnaire. The protocol of this study was approved by the Ethics Committee of the NOVA National School of Public Health - Universidade NOVA de Lisboa on 18th January 2023 (no. 25/2022) (Appendix 1).

Questionnaire design

The questionnaire was developed in Portuguese, based on previous instruments and literature (12,30,31). It was divided into seven sections: 1. immunisation behaviour; 2. vaccine safety and efficacy; 3. access to the National Vaccination Programme; 4. vaccination schedule; 5. role of healthcare professionals; 6. parent vaccination status (National Vaccination Program and COVID-19 vaccines); and 7. sociodemographic data (Appendix 2). The questions included in sections 1, 4 and 5 were adapted from the Parent Attitudes about Childhood Vaccines survey (30) and its validated Brazilian Portuguese version (31). The questions in sections 2 and 5 were based on the questionnaire suggested by Larson *et al*. (12).

A first version of the questionnaire, declaration of consent and study informative sheet were reviewed by eight people of the informal network of the first author, on a Microsoft® Word document. The objective was to assess clarity, readability, and understanding. The revision resulted in minor changes. After, the documents were implemented online on REDCap, and the questionnaire was validated through cognitive interview techniques (think-aloud and verbal probes procedures) with four mothers of children between 17 and 19 months (slightly older than the target population, but in similar conditions). Overall, the feedback was positive in terms of recall, readability and choosing pattern. There were doubts about what to consider a vaccination delay, so an open-ended question was introduced asking why people delayed or refused vaccination. The authors discussed the feedback given on the interviews and decided on the final details of the questionnaire.

Questionnaire dissemination

The questionnaire was disseminated online using a convenience sampling method. Firstly, two childcare lists (from three months old to 24 months) from the Social Solidarity Particular Institutions all over the country were consulted. The institutions' emails that were unavailable on these lists were searched on the Internet by three general training medical residents and saved on an Excel file. A list of public and private schools from three municipalities of the Lisbon Metropolitan Area and one municipality from the North were also scanned for childcare and kindergartens. The digital platforms of the government social security ('Carta Social') and 'Growappy' were consulted to find childcare emails in different regions of the country. As time was limited, having the emails from all the childcares in Portugal was impossible. Thus, the purpose was to include childcare from different regions of the country. A total of 1,818 emails from childcare and kindergartens were found and organised by the first author and the three medical residents, during March 2023, with the following distribution: Lisbon Metropolitan Area (42.6%), North (22.7%), Centre (14.2%), Algarve (11.7%), Alentejo (8.4%), Autonomous Region of Azores (0.4%); emails from Autonomous Region of Madeira were not searched. The first author prepared an informative email about the study, with links to the questionnaire, an informative sheet (Appendix 3), and a poster for affixation on the wall (Appendix 4). These emails were sent to childcare and kindergartens, inviting them to share the questionnaire with parents of children aged 17 months or less in May 2023.

The first author prepared a text and a picture to share the study on her social media and adapted them to Facebook, Instagram, Twitter and Linkedin (Appendix 5). The other authors also shared the link to the questionnaire on their social networks in May 2023.

Additionally, forty-five Portuguese blogs and Instagram accounts related to motherhood, babies and health, were found online and contacted by email or direct message on Instagram. Six influencers shared the questionnaire link on their Instagram stories in May/June 2023. The first author was also asked to write a blog post about the National Vaccination Programme and vaccine hesitancy to share the study in one blog in June 2023.

Eligibility criteria

Participants were eligible for the study if they had at least one child aged 17 months old or less, were living in Portugal and were able to answer the questionnaire. We excluded participants who did not submit the questionnaire and answered a questionnaire about vaccination in children during the previous month. The first was implemented due to the anonymous nature of the questionnaire. If a participant wanted to quit, the only option was to not submit the questionnaire (this information was presented in the consent and information sheet). In this case, even if some answers had already been saved, these responses were not included in the analysis. The second criterion was implemented to minimise the risk of duplicate answers, as these were impossible to identify and exclude after the submission of the questionnaire. Only participants who responded to the question related to the delay or refusal of their child vaccines were included.

Variables

The outcome was parental childhood vaccine hesitancy, assessed by the single choice question 'Have you ever delayed or refused having your child get a shot for reasons other than illness or allergy? Only consider the vaccines included in the National Vaccination Programme (free vaccines recommended to your child).'. The possible answers included: 'Yes, I have delayed.', 'Yes, I have refused.', 'Yes, I have delayed and refused.' and 'No, I have never delayed nor refused.'. Participants who selected 'Yes, I have delayed.', 'Yes, I have refused', or 'Yes, I have delayed and refused.' had a subsequent open-ended question on why they had delayed vaccination. These reasons validated whether the delay should be considered vaccine hesitancy (outcome). After recategorisation, the final outcome had two possible answers: 'no', corresponding to participants who have not delayed or refused vaccination for their child or delayed it for a reason non-coincident to vaccine hesitancy, and 'yes', corresponding to participants who refused vaccination, and/or delayed vaccination because of vaccine hesitancy, or that have not specified the reason (and thus it was impossible to know).

The exposure variables were related to vaccination and the National Vaccination Programme – sections 2-5 of the questionnaire. Each section comprised two to six statements with 5-point Likert scale answers (fully disagree; disagree; neither agree nor disagree; agree; fully agree).

All sociodemographic and parental vaccine hesitancy variables were initially considered possible confounding factors.

Statistical methods

Firstly, the data was validated, and eligibility criteria were applied. A descriptive analysis of the sample on sociodemographic characteristics was performed. The proportion of parental childhood vaccine hesitancy was estimated, with a 95% confidence interval (95% CI), using the Wilson score intervals.

We implemented an exploratory factor analysis for the four sections assessing 2. Vaccine safety and efficacy; 3. Access to the National Vaccination Programme; 4. Vaccination schedule; and 5. Role of healthcare professionals. Negative items were inverted for analysis purposes. Due to a high proportion of missing values (38.1%), the item 'immune system' ('My child's immune system is not prepared for vaccines as they are scheduled.') was excluded from the analysis. We checked the suitability for an exploratory factor analysis using the Kaiser-Meyer-Olkin (KMO) test for sampling adequacy (overall measure of sampling adequacy = 0.86) and the Bartlett's test of sphericity (p-value = 0). An exploratory factor analysis with oblique rotation was performed. Items with standardised loadings higher than 0.4 were included and originated five new dimensions: 1. Vaccine confidence; 2. Access to enough/reliable information about vaccines; 3. Access to National Vaccination Programme; 4. Vaccination schedule; and 5. Trust in healthcare professionals' information about vaccines. The internal consistency of each dimension, assessed by the Cronbach's alpha (α), was moderate to high (Table 1).

To assess which dimensions were associated with parental childhood vaccine hesitancy, logistic regressions were performed using the dimensions' scores extracted from the exploratory factor analysis. To decide the confounding factors, univariate logistic regressions were performed for all sociodemographic and parental vaccine hesitancy variables. Only variables with a statistically significant association (p-value <0.001) with the outcome were included in the adjusted analysis. Only respondents who answered all the analysed questions were included. Crude and adjusted odds ratios with 95% confidence intervals were estimated for the five dimensions.

All analyses were performed using R, version 4.3.0 (32). For descriptive and regression analyses, we used the package 'gtsummary' (33) and for exploratory factor analysis, the packages 'psych' (34) and 'GPArotation' (35).

Table 1 Items of the questionnaire included each of the five dimensions

Vaccine confidence (*α*=0.90) • Childhood vaccines are effective. • Childhood vaccines are safe. • Childhood vaccines are important for my child's health.
Access to enough/reliable information about vaccines (*α*=0.93) • I have access to enough information about vaccines and their efficacy. • The information I receive about vaccines from the vaccine programme is reliable and trustworthy.
Access to the National Vaccination Programme (*α*=0.72) • The health unit always has vaccines for my child. • It is easy to arrange my child's vaccination for the right month. • I feel welcome when vaccinating my child in the health unit. • I need to go to the health unit too often to vaccinate my child. *(inverted)*
Vaccination schedule (*α*=0.86) • My child is recommended too many vaccines. *(inverted)* • My child is recommended too many vaccines in each health unit visit. *(inverted)* • My child´s recommended vaccines are against too many diseases. *(inverted)* • I believe that many of the illnesses vaccines prevent are not severe. *(inverted)*
Trust in healthcare professionals' information about vaccines (*α*=0.89) • I trust the information that healthcare professionals provide about vaccines. • I believe healthcare professionals are well-informed about vaccines.

Results

Of the 1,099 people who consented to participate in the study, 257 dropped out before submitting the questionnaire (Figure 1). Of these, only those who did not answer a questionnaire about vaccination in children during the previous month (n = 857) were included. Of those who had a child with 17 or fewer months, 790 provided information to the parental childhood vaccine hesitancy questions.

The mean child age was 10.1 months old (±4.8) (Table 2) and the mean parent's age was 33.8 years old (±4.3). The female to male children ratio was, approximately, 1:1. Most of the participants were mothers (95.2%) and lived in Lisbon Metropolitan Area (38.5%) or in the North region (31.0%), and were employed (90.2%). Most households included someone who had completed high education (85.2%), and about half did not have a health-related high education degree (56.0%). About two-thirds could easily pay all the usual expenses (65.4%).

Forty-four participants have indicated the reason for delaying or refusing their child's vaccination (Table 3). Most reasons were unrelated to vaccine hesitancy (77.3%). The reasons identified as vaccine hesitancy were deliberate delay (9.1%), the excessive number of simultaneous vaccines (9.1%) and lack of confidence in vaccines (4.5%). The proportion of parental childhood vaccine hesitancy was estimated at 1.8% (95% Confidence Interval – 95% CI: 1.0%-3.0%).

Figure 1 Flow diagram considering eligibility criteria

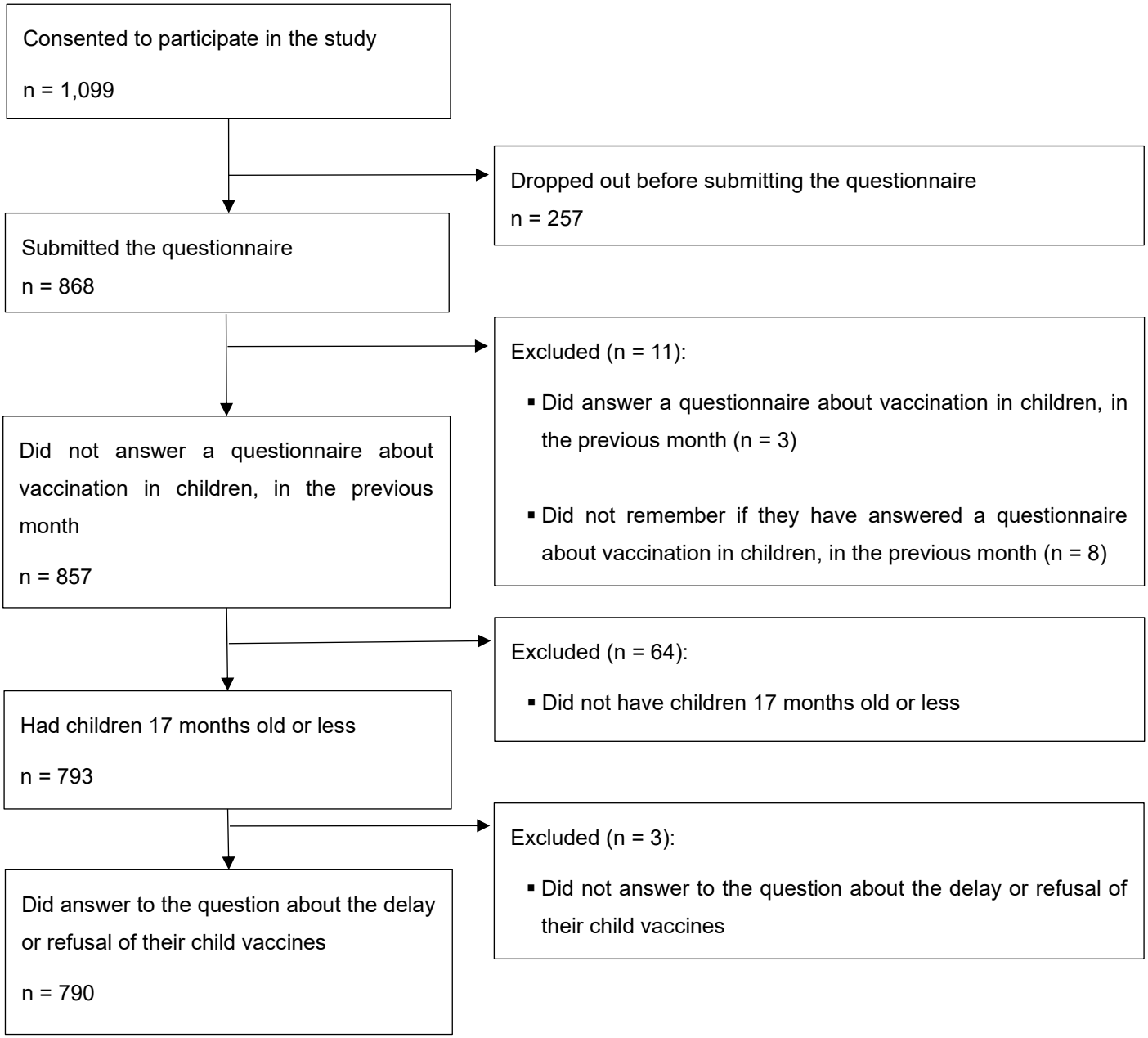

Table 2 Characteristics of the participants in the study

Participants' characteristics	**n (%)**
Child's age (in months) (n = 790) *mean (sd)*	10.1 (4.8)
Parent's age (in years) (n = 760) *mean (sd)*	33.8 (4.3)
Child's sex (n = 786)	
Female	396 (50.4%)
Male	390 (49.6%)
Parent's sex (n = 788)	
Female	750 (95.2%)
Male	38 (4.8%)
Region of residence (n = 787)	
Lisbon Metropolitan Area	303 (38.5%)
North	244 (31.0%)
Centre	147 (18.7%)
Algarve	48 (6.1%)
Alentejo	29 (3.7%)
Autonomous Region of Madeira	11 (1.4%)
Autonomous Region of Azores	5 (0.6%)
Occupation (n = 788)	
Employed	711 (90.2%)
Unemployed or inactive	77 (9.8%)
Household's highest educational level completed (n = 788)	
High education	671 (85.2%)
Low or medium education	117 (14.8%)
Household's health-related high education degree (n = 671)	
Yes	295 (44.0%)
No	376 (56.0%)
Household's ability to pay unexpected expenses of 555€ with own means* (n = 766)	
Yes, and would not have to reduce the usual expenses	373 (48.7%)
Yes, but would have to reduce the usual expenses	249 (32.5%)
No	88 (11.5%)
Do not know	47 (6.1%)
Yes, but do not know how or prefer not to answer	9 (1.2%)
Household's ability to pay all the usual expenses* (n = 754)	
With easiness	493 (65.4%)
With difficulty	258 (34.2%)
Do not know	3 (0.4%)

sd = standard deviation

***Household's ability to pay unexpected expenses of 555€ with own means and household's ability to pay all the usual expenses questions were obtained from the European Union Statistics on Income and Living Conditions (EU-SILC) questionnaire (36)

Table 3 Reasons why people delayed or refused the vaccination of their child (n=44)

Reasons not considered as vaccine hesitancy	**n (%)**
Illness of the child	15 (34.1%)
Structural factors	12 (27.3%)
Oblivion	7 (15.9%)
Reasons considered as vaccine hesitancy	
Deliberate delay	4 (9.1%)
Too many simultaneous vaccines	4 (9.1%)
Lack of confidence in vaccines	2 (4.5%)

Crude and adjusted odds ratios with 95% confidence intervals for the five dimensions are presented in Table 4. At first, an univariate logistic regression was performed for each sociodemographic and parental vaccine hesitancy variable. Only parental vaccine hesitancy variables (parental vaccine hesitancy related to the National Vaccination Programme (Odds Ratio – OR=27.7, 95% Confidence Interval – 95% CI: 7.18-182.0) and parental vaccine hesitancy related to COVID-19 vaccines (OR=15.1, 95% CI: 4.01-98.2) were significantly associated with the outcome (parental childhood vaccine hesitancy) and used as confounders.

These results point to a protective role of vaccine confidence, vaccination schedule and trust in healthcare professionals' information about vaccines dimensions regarding vaccine hesitancy. Parents with higher vaccine confidence were 71% less likely to hesitate to vaccinate their child (adjusted Odds Ratio – aOR=0.29, 95% CI: 0.14-0.54). Those who trust healthcare professionals' information about vaccines have a 70% less chance of hesitating when vaccinating their child (aOR=0.30, 95% CI: 0.16-0.53). Agreeing with the vaccination schedule was also associated with a 69% lower chance of parental childhood vaccine hesitancy (aOR=0.31, 95% CI: 0.15-0.58). Parents who consider having access to enough or reliable information about vaccines may be less hesitant (OR=0.48, 95% CI: 0.29-0.83), although this dimension is not statistically significant when adjusting for parent's vaccine hesitancy (aOR=0.90, 95% CI: 0.51-1.69). Access to the National Vaccination Programme may be associated with a reduction of 33% in parental childhood vaccine hesitancy, although this result was not statistically significant (aOR=0.67, 95% CI: 0.37-1.33).

Table 4 Crude (n = 756) and adjusted (n = 723) regression analyses

Dimensions	**OR (95% CI)**	**aOR (95% CI)**
Vaccine confidence	**0.21 (0.11-0.35)**	**0.29 (0.14-0.54)**
Access to enough/reliable information about vaccines	**0.48 (0.29-0.83)**	0.90 (0.51-1.69)
Access to the National Vaccination Programme	0.57 (0.35-1.02)	0.67 (0.37-1.33)
Vaccination schedule	**0.21 (0.11-0.37)**	**0.31 (0.15-0.58)**
Trust in healthcare professionals' information about vaccines	**0.25 (0.15-0.40)**	**0.30 (0.16-0.53)**

OR - Odds Ratio; aOR - Adjusted Odds Ratio; 95% CI - 95% Confidence Interval

Analyses were adjusted for parent's own hesitancy on National Vaccination Programme and COVID-19 vaccination. Statistically significant results are in bold.

Discussion

To the best of our knowledge, this is the first study in Portugal to analyse vaccine and vaccination-specific issues related to vaccine hesitancy in parents of babies and toddlers. In this study, the proportion of parental childhood vaccine hesitancy was estimated at 1.8%. Vaccine confidence, trust in healthcare professionals' information about vaccines, and vaccination schedule were associated with lower vaccine hesitancy.

In this study, the proportion of vaccine hesitancy in parent's of children aged 17 months old or less was 1.8% (95% CI: 1.0%-3.0%). Other studies in Portugal have estimated higher values. A self-reported vaccine hesitancy of 9% was observed in a sample of parents of children aged 1-4 years old (28). Studies in older children have estimated refusals of 3.6% (18) and 5,4% (29), and delays of 9.8% (29). The fact that, in our study, reasons why parents delayed or refused vaccination were used to validate vaccine hesitancy may justify the lower value obtained, as not all vaccination delays are due to vaccine hesitancy. Also, vaccination coverage levels in Portugal seem to reduce when children's age increases (37–40), which may correspond to a higher vaccine hesitancy among parents of older children and adolescents. This may explain the lower vaccine hesitancy proportion found in our study compared to the ones that included parents of older children (18,29). A low proportion of vaccine hesitancy aligns with the high immunisation coverage and parental vaccine confidence observed in this country (4,6,9,28).

As reported in other studies, vaccine confidence seems to be a protective factor regarding vaccine hesitancy (15,18–22). In European Union, vaccine confidence monitoring is used to better understand vaccine hesitancy in each country (11), showing the tight link between vaccine confidence and hesitancy. In our study, the vaccine confidence dimension included vaccine safety and efficacy (20), and its health benefit perception (21). Vaccine safety and efficacy are among the main concerns of vaccine-hesitant parents (15,18,20–22); this was also observed in Portugal (18) and, in our study, lack of confidence in vaccines was mentioned as a reason for vaccination delay or refusal. For vaccine-hesitant parents, the individual effect of vaccines on their child is more important than contributing to herd immunity and public health (22,25,26). Being focused on the side effects of vaccines and having a low risk perception of vaccine-preventable diseases (complacency) are arguments used by parents to support their decision to delay or refuse children's vaccination (13,15,17,23,25,26).

Not having access to enough or reliable information about vaccines (18,20,21,23,24) may also be associated with vaccine hesitancy among parents of young children, although adjusted results were not significant in our study. Information about vaccines may come from official, trusted sources but also from alternative sources. While hesitant parents seem to need to look for more information about vaccines (21,23,24), non-hesitant parents have more trust in doctors and health professionals (20,21,23,24). Healthcare providers play an important role, as they are usually seen as the most reliable source (17,22,27) and may positively influence an undecided parent towards vaccination (15,25). However, if enough information is not given or comes later in the parents' decision process, they may seek advice from alternative sources (17,22,25,41). This may explain why, in our study, parents who trust healthcare professionals' information about vaccines are less hesitant. Since nurses and doctors in Portugal have a high level of confidence in vaccines and mostly agree that vaccines are important (99.2%), safe (99.8%) and effective (99.6%) (11), there seems to be a favourable context for their early intervention in reducing parental vaccine hesitancy (22,25,41).

In this study, the access to the National Vaccination Programme dimension comprised items related to the availability of vaccines and vaccination services, feeling welcome on vaccination sites and the frequency of vaccination. Although the results on this dimension were not statistically significant, the point estimation suggests that access to the National Vaccination Programme may be a protective factor against parental vaccine hesitancy. Facilitating this access may lower the chance of vaccine hesitancy (15,24), which aligns with the need for vaccination services to be available (convenience) when defining vaccine hesitancy (13). In Portugal, accessibility is one of the principles of the National Vaccination Programme (14), which should be guaranteed to maintain high immunisation coverage.

The vaccination schedule, which is one of the aspects of the National Vaccination Programme, may play a specific role in vaccine hesitancy (15,19–24,26). In our study, agreement with the vaccination schedule was associated with a lower chance of vaccine hesitancy. The number of vaccines children take on each visit is a cause of concern among parents, as they think it may lead to unnecessary pain and are also afraid that the immune system may not be prepared (22,25,26). In our study, excessive simultaneous vaccines were pointed out as a reason for vaccine delay or refusal. Ensuring that children's vaccination is not a harmful experience for parents is crucial to keep their acceptance of the scheduled vaccines (15,17). Changes in the vaccination schedule over time may lead to parents' doubts (15,15,22), and having different

schedules within the same country may also contribute to suspicion (22,26). The National Vaccination Programme in Portugal is universal, and its schedule is the same for the whole country (14). This may contribute to strengthening parent's confidence in recommended vaccines.

Strengths

Our study adds to the knowledge about vaccine and vaccination-specific issues and their relation with vaccine hesitancy in Portugal. The questionnaire used was mostly based on validated instruments (30,31) and literature (12). In our study, it was possible to aggregate 15 items of the questionnaire within five dimensions with moderate to high internal consistency. These dimensions may be used in future studies to assess vaccine confidence, access to information about vaccines and the National Vaccination Programme, the vaccination schedule and trust in information provided by healthcare professionals. More mothers than fathers have participated in the study, as it usually happens (24,27,42). This may be a strength as decisions related to vaccination and vaccine information search are usually taken by mothers (22,27). Another strength is the minimal recall bias since questions concerned the past 17 months in total.

Limitations

This study has some limitations. The cross-sectional design prevents the establishment of a causal relationship between the exposure and the outcome (43). Using an online questionnaire and sharing it may have introduced a selection bias, as people with easier Internet access and social media may not be representative of the target population (44). Additionally, people with a positive perspective on vaccination may be more motivated to participate (17), which may have contributed to the low proportion of vaccine hesitancy obtained in our study. The participants' household's highest educational level completed and economic status differ from the general population (45,46). The influence of socioeconomic status on parental vaccine hesitancy is still unclear, as it may be a promoter or a barrier depending on the context (13,47). In Portugal, there seems to be no association between the highest educational level and vaccine confidence (11). A social desirability bias should not be ruled out, especially because the first author was identified as a medical doctor. Nevertheless, using an online

anonymous questionnaire may have contributed to reduce this bias. Checking children's vaccination records instead of self-reported data may improve this aspect in future studies.

Implications

Our study points to the contribution of some modifiable aspects of vaccination and the National Vaccination Programme to parental childhood vaccine hesitancy. Successful strategies to tackle parental childhood vaccine hesitancy are usually multi-component and tailored to the target population (48). The role of healthcare professionals seems to be a crucial part of them (48) and our results show that trusting information provided by healthcare professionals may influence on parents' decision. Providing balanced information on the risk and benefits of vaccines may be effective in reducing vaccine hesitancy (48), probably contributing to enhanced trust in healthcare professionals.

Future studies should aim to deeper understand which aspects of vaccine confidence, vaccination schedule and trust in information provided by healthcare professionals are related to vaccine hesitancy. A qualitative study may help to better comprehend which changes to the National Vaccination Programme would be important to implement in order to increase hesitant's parent's confidence in vaccination. It would also be important to assess the factors contributing to parental childhood vaccine hesitancy in each region of the country, in order to address directed strategies to tackle this issue.

Conclusions

A reduced proportion of parental childhood vaccine hesitancy was observed in our study, with lower levels than in other studies performed in Portugal. The different age ranges of the studied population may explain this difference. However, a low proportion of vaccine hesitancy is coherent with the high immunisation coverage and parental vaccine confidence reported in Portugal.

Vaccine confidence, vaccination schedule and trust in healthcare professionals' information about vaccines were the dimensions in our study which had the greatest influence on vaccine hesitancy. A timely approach by healthcare professionals may contribute to elucidate vaccine-hesitant parents and increase their confidence in the National Vaccination Programme. The vaccination schedule is a cause of concern among parents. A further understanding of which aspects drive vaccine hesitancy may contribute to finding suitable reduction strategies.

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Appendices

Appendices are available on a separate volume (PDF file ‘Appendices’).