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Intention to vaccinate chronic disease children against COVID-19; a multicenter survey

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Abstract

Background Vaccination against severe acute respiratory distress syndrome coronavirus 2 (SARS-CoV-2) has gained recognition as a crucial strategy to prevent and reduce the risk of infection, including emerging variants, due to its proven safety, immunogenicity, and effectiveness. This study aimed to evaluate the vaccination hesitancy (VH) among Egyptian parents towards SARS-CoV-2 vaccination, specifically focusing on parents with chronically ill children.

Method A multicentered cross-sectional survey was conducted at outpatient clinics of El-Raml Pediatric Hospital, Ministry of Health and Population (MOHP) in Alexandria, Alexandria Main University Hospital for Maternity and Children (AMUH), Al-Galaa Teaching Hospital, General Organization for Teaching Hospitals and Institutes (GOTHI) Cairo, and Pediatric Department, Menoufia University Hospital from May 1st till December 15th, 2022. Parents of children with chronic diseases were recruited using a simple random sampling technique to respond to the validated Arabic version of parental attitudes about childhood vaccination (PACV).

Results In this study, we enrolled 527 caregivers, 55.4% of them were aged 30–39 years old, 85.2% were females, and 46.9% had chronic diseases. Commonly mentioned information sources included television and radio (69.8%), and social media (35.3%). Among the parents studied, 59.6% refused vaccination. The predictors of the PACV score were governorate, Menoufia ($\beta = 11.30$, 95%CI [5.32, 17.27], $p < 0.001$), study setting, Menoufia University Hospital ($\beta = -20.07$, 95%CI [-25.40, -14.75] and El-Raml Hospital ($\beta = -10.74$, 95%CI [-14.50, -6.98], $p < 0.001$), income; not enough and loans repaid ($\beta = 3.18$, 95%CI [0.54, 5.82], $p = 0.018$) and not enough and loans not repaid ($\beta = 3.57$,95%CI [0.08, 7.07], $p = 0.045$).

Conclusions The study reveals geographic and economic factors as predictors of PACV, and emphasizes the need for region-specific interventions and financial barriers to improve vaccine acceptance and child well-being.

Keywords Vaccine hesitancy, Vaccine acceptance, COVID-19, SARS-CoV-2, Chronic diseases, Parental attitude towards children vaccination

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Background

The potentially deadly coronavirus disease 2019 (COVID-19), which mostly affects the respiratory system, is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 exhibits recognized but varying morbidity and mortality patterns [1, 2]. Besides triggering a devastating economic crisis [3], the COVID-19 pandemic affected every aspect of life [4–7]. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 as a worldwide pandemic [8]. On October 25, 2023, approximately 771.5 million cumulative cases and 6.9 million deaths due to COVID-19 were reported globally. In Egypt, 516,023 cases of COVID-19 and 24,830 deaths have been reported so far [9]. Egypt adopted additional public health and societal measures to combat the pandemic in addition to mass vaccination [10]. Since January 24, 2021, Egypt has distributed 112.6 million doses of COVID-19 vaccines, equaling nearly 110.1 total doses administered per 100 population [9]. In an effort to expand the coverage of vaccination in rural areas, including children over 12 years of age, the Egyptian Ministry of Health and Population (MOHP) has initiated a proactive approach. They have deployed mobile teams to regions with low vaccination rates, bolstered by the support of healthcare workers [11].

Studies have indicated that the viral load in the nasopharynx of children is equivalent to or greater than that in adults, although the symptoms in children are less severe than those of adults [12]. Children may play a crucial role in transmitting the virus since they must go to school and other regular gatherings. Children with malignancies, hematological disorders, neurological conditions, heart diseases, neonates, and other specific medical conditions represent a high-risk group vulnerable to SARS-CoV-2 infection. When developing vaccination strategies for young people, it is crucial to include and prioritize these particular groups [13].

Due to its safety, immunogenicity and effectiveness, vaccination against SARS-CoV-2 has been recognized as a critical approach to prevent and reduce the risk of infection, particularly emerging variants of the virus [14, 15]. However, a notable obstacle to the immunization of children has emerged, namely parental vaccine hesitancy (VH). The phenomenon of VH among parents poses a significant challenge in achieving widespread vaccination coverage, even in the face of effective vaccines [16]. VH is listed among the top 10 threats to global health [17]. It is defined as a “delay in the acceptance or refusal of vaccines despite their availability” [18]. The safety and probable side effects of COVID-19 vaccination are apprehensive of many parents, which could raise their VH [19]. Misinformation and false information concerning COVID-19 can have a harmful influence on individuals’ attitudes toward vaccination [18, 20]. The well-known questionnaire "Parent Attitudes about Childhood Vaccines" (PACV) may be effectively used to examine parental COVID-19 VH. The PACV survey has been shown to be useful in detecting anti-vaccination parents and predicting future VH [21, 22]. The PACV has been proven to be externally valid as well [23].

This study hypothesized that a substantial proportion of parents with children with chronic diseases can demonstrate VH towards COVID-19 vaccination. To enhance the effectiveness of policies and healthcare strategies aimed at controlling the pandemic, it is imperative to prioritize an understanding of parents’ intentions regarding their children’s vaccination and the factors that influence these decisions. By assessing the extent of parental VH and identifying its key determinants, we can take significant steps toward improving vaccine acceptance and strengthening population immunity. Therefore, the objective of this study was to evaluate parental VH among Egyptian parents of children with chronic diseases with respect to the vaccination with COVID-19.

Methods

Study design and settings

This multicenter cross-sectional study was conducted in 3 governorates (Alexandria, Cairo, and Menoufia). Parents were recruited from the outpatient clinics of El-Raml Pediatric Hospital (MOHP), Alexandria, Alexandria Main University Hospital (AMUH) for Maternity and Children (El-Shatby), Al-Galaa Teaching Hospital, General Organization for Teaching Hospitals and Institutes (GOTHI), MOHP, Cairo, and Pediatric Department, Faculty of Medicine, Menoufia University, Menoufia from May 1st till December 15th, 2022.

Target population and eligibility for participation

Parents or guardians of children between the ages of 3 and 12 who have chronic diseases and receive medical services from outpatient clinics in the designated study settings were invited to participate in the study. The recruitment process used the simple random technique, and these parents or guardians were asked to complete the study questionnaire. The study excluded children with terminal diseases or advanced severe comorbid diseases. Furthermore, parents or guardians under 18 years of age and those with mental disabilities or communication difficulties were excluded from the study.

Sample size and sampling technique

Based on a previous study conducted in Egypt, the VH among parents of children with cerebral palsy was 70.0% [24], the minimum sample size required to evaluate the

VH of parents was 323 assuming the margin of error = 5, power = 80.0% and design effect 1.

Questionnaire of data collection

Parents of children with chronic conditions were interviewed in person by trained physicians. There were four sections in the questionnaire. The age, sex, education level of the parents, the number of children, the relationship with the children, the type of employment (i.e., government, private or jobless), health insurance coverage and income level (i.e., not enough, on a loan and cannot pay back; not enough, on a loan but can pay it back; enough; or enough and saving) were included in the sociodemographic section. The second section included questions about the history of chronic disease, the history of COVID-19 infection, vaccination status (full vaccination, receiving all COVID-19 primary series doses), partial vaccination, not receiving any doses of vaccine, receiving booster dose, receiving booster dose at least two months after primary series doses), reasons for refusal of administration or completion, and sources of information on COVID-19 vaccines. Characteristics of the children were described in the third section (i.e., child age, sex, previous vaccination history and history of chronic diseases). The validated Arabic translation of the PACV survey was included in "Discussion" section [25] (Supplementary file S1). The calculation of the total PACV score was explained elsewhere [21]. Parents who scored 50 or above were categorized as hesitant, while those who scored below 50 were non-hesitant.

Statistical analysis

Statistical Package for Social Sciences (SPSS) software (version 26) was used to handle, display, and perform statistical analyzes. Parental VH toward immunizing their children with COVID-19 vaccination was the primary outcome of the present study. Descriptive statistics were used to present sociodemographic data from parents and their chronically ill children, with measures such as mean and standard deviation for numerical data and frequency distribution presented as number and percentage (percent) for categorical variables. The Mann-Whitney U test (non-parametric test) was used to determine whether there were differences in the distributions of the two groups when the data were not normally distributed, and the assumption of t-test was not met. A ranked-based nonparametric test, the Kruskal–Wallis H test (also known as the "one-way ANOVA on ranks") was used to assess if there are statistically significant differences between three or more groups of an independent variable. A post hoc test was performed to determine which specific groups differ from each other. Independent variables with a p-value of less than 0.20 in the bivariate analysis were retained and incorporated into a multilinear regression analysis to confirm their association with parents' intention to vaccinate their children. We checked for the following assumptions of the model linearity, independence, homoscedasticity, normality of residuals, and no perfect multicollinearity. Findings with a p-value less than 0.05 were considered significant.

Results

In this study, we enrolled 527 caregivers, 55.4% of them were aged 30–39 years, 85.2% were females, 48.0% were from Alexandria, 81.6% were mothers, 85.4 had one child, 77.0% had high school education or less, 68.5% were not employed, 93.5% were non-HCWs, 45.9% self-reported enough monthly income, 38.7% had elders as a family member, and 37.1% had family size of 4 or less (Table 1).

COVID-19 related history

Table 2 shows that 30.0% of the parents had a prior SARS-CoV-2 infection, 47.4% did not report such an infection, and 22.6% were uncertain about their previous infection status. Regarding COVID-19 vaccine status: 11.0% of the respondents had taken all three doses (primary serious and booster dose) of the vaccine, 28.3% did not want to take the vaccine at all, 7.2% expressed their desire to take the vaccine but had not scheduled for it yet, 21.6% had taken the first and second doses and were awaiting the booster dose, while 16.3% had taken the first and second doses but chose not to take the booster dose, 7.8% had taken the first dose and were waiting for the second, and 7.8% took the first dose but refused the second dose.

The reasons for not completing the COVID-19 vaccination schedule were as follow: 46.4% indicated it was not applicable (already took the three doses, does not want to take the vaccine, or scheduled for the first dose), 29.4.% were waiting for the next dose, 3.2% mentioned the unavailability of the vaccine, and 21.8% refused to complete the vaccination. A small percentage mentioned that they were pregnant or lactating (0.9%), had autoimmune diseases (as rheumatoid arthritis and systemic lupus) (0.2%), and other reasons (2.7%).

Among those who refused vaccination, the table provides insight into their reasons. Fear of having COVID-19 after vaccination (53.0%), fear of side effects (67.1%), non trust in vaccine efficacy (65.1%), non trust in available vaccination (14.0%), and insufficient information about the vaccines (11.4%) were the main factors mentioned. The data reveals that 46.9% of the respondents reported having a chronic disease such as diabetes mellitus (19.4%), hypertension (32.8%), respiratory diseases (bronchial asthma and chronic obstructive pulmonary disease (COPD)) (34.0%), rheumatic and immunogenic diseases (16.6%),

Table 1 Characteristics of parents of children with chronic diseases who were surveyed regarding their hesitancy toward COVID-19 vaccination ($N = 527$)

Variables		N (%)
Caregivers' criteria		
Age (years)	18–29	104 (19.7)
	30–39	292 (55.4)
	40–49	106 (20.1)
	50–59	23 (4.4)
	≥ 60	2 (0.4)
Gender	Female	449 (85.2)
	Male	78 (14.8)
Site of data collection	El-Raml Hospital	140 (26.6)
	Al-Galaa Hospital	140 (26.6)
	Menoufia Hospital	100 (19.0)
	Alexandria Main University Hospital	147 (27.9)
Residence (governate)	Cairo	57 (10.8)
	Alexandria	253 (48.0)
	Giza	81 (15.4)
	Behira	61 (11.6)
	Menoufia	61 (11.6)
	Others	14 (2.6)
Relation to the child	Mother	430 (81.6)
	Father	67 (12.7)
	Other	30 (6.7)
Number of children having chronic disease	1	450 (85.4)
	2	63 (12.0)
	≥ 3	14 (2.7)
Educational level	High school or below	406 (77.0)
	University degree	109 (20.7)
	Postgraduate degree	12 (2.3)
Occupation sector	Government sector	77 (14.6)
	Private sector	89 (16.9)
	Not employed	361 (68.5)
Working time	Work from home	29 (5.5)
	Part-time	19 (3.6)
	Full-time	124 (23.5)
	Not employed	355 (67.4)
Work sector	Health	34 (6.5)
	Non-health	493 (93.5)
Health insurance	Uncovered	415 (78.7)
	Covered	112 (21.3%)
Monthly income	Not enough, on a loan and cannot pay back	80 (15.2)
	Not enough, on a loan but can pay back	195 (37)
	Enough	242 (45.9)
	Enough and save	10 (1.9)
Older adults living in the household	No	323 (61.3)
	Yes	204 (38.7)
Family size	≤ 4 members	196 (37.1)
	5 members	190 (36.1)
	> 5 members	141 (26.8)

Table 2 COVID-19-related history and history of chronic diseases among parents and gurdians of children with chronic diseases

Variable		N (%)
Previous SARS-CoV-2 infection	Yes	158 (30.0)
	No	250 (47.4)
	Not sure	119 (22.6)
COVID-19 vaccine status	Took the three doses	58 (11.0)
	Does not want to take the vaccine	149 (28.3)
	Wants to take the vaccine, but it is not scheduled yet	38 (7.2)
	Took the first and second doses and is awaiting the booster dose	114 (21.6)
	Took the first and second doses but did not want to take the booster dose	86 (16.3)
	Took the first dose and is awaiting the second	41 (7.8)
	Took the first dose but does not want to take the second dose	41 (7.8)
Causes of non-completion COVID-19 vaccination	Not applicable	245 (46.4)
	Waiting for the next dose	155(29.4)
	Vaccine not available	17 (3.2)
	Refuse to complete	115 (21.8)
	Pregnancy or lactation	9 (0.9)
	Autoimmune disorders	4 (0.2)
	Others	14 (2.7)
Causes of refusal of vaccination *n* = 149	Fear of having COVID after vaccination	79 (53.0)
	Fear of side effects	100 (67.1)
	Non trust in vaccine efficacy	97 (65.1)
	Non trust in the available vaccination	21 (14.0)
	Insufficient information about the vaccine	17 (11.4)
Chronic diseases	No chronic disease	280 (53.1)
	Have chronic disease	247(46.9)
	• Respiratory diseases (Bronchial asthma, COPD)	84 (34.0)
	• Hypertension	81 (32.8)
	• Rheumatic& immunogenic diseases	41(16.6)
	• Diabetes mellitus	48 (19.4)
	• Motor disability	8 (3.2)
	• Cardiac diseases	21 (8.5)
	• Renal and hepatic diseases	11 (4.4)
	• Neuropsychiatric disorders	10 (4.0)

COPD chronic obstructive air way diseases, *SARS-CoV-2* Severe acute respiratory syndrome coronavirus 2, *COVID-19* coronavirus disease 2019

motor disabilities (3.2%), cardiac diseases (8.5%), renal and hepatic diseases (4.4%), while 53.1% did not have any chronic disease.

The survey participants got information on COVID-19 vaccination from a variety of sources. Commonly mentioned sources included television and radio (69.8%), family and friends (23.8%), and social media (35.3%). Some respondents also relied on books and research (2.0%), online websites (11.2%), and family physicians (1.8%) (Fig. 1).

Characteristics of studied children

The median age of the children was 6 years, ranging from 3.0 to 12.0 years, 40.0% of the children were females, 6.3% had a confirmed COVID-19 infection, 76.9% did not have COVID-19, and 16.9% were unsure of their COVID-19 status, the most common chronic disease was respiratory disease, affecting 88.6% of the children, and 86.9% of the children received compulsory vaccination as mandated by the MOHP, 22.6% received seasonal flu vaccination (Table 3).

Regarding child vaccination against COVID-19, 59.6% of the respondents rejected vaccination, while 40.4% accepted it. Respondents who accepted vaccination were further asked about the type of vaccine they preferred. AstraZeneca (1.5%), Pfizer (12.1%), Johnson (12.1%),

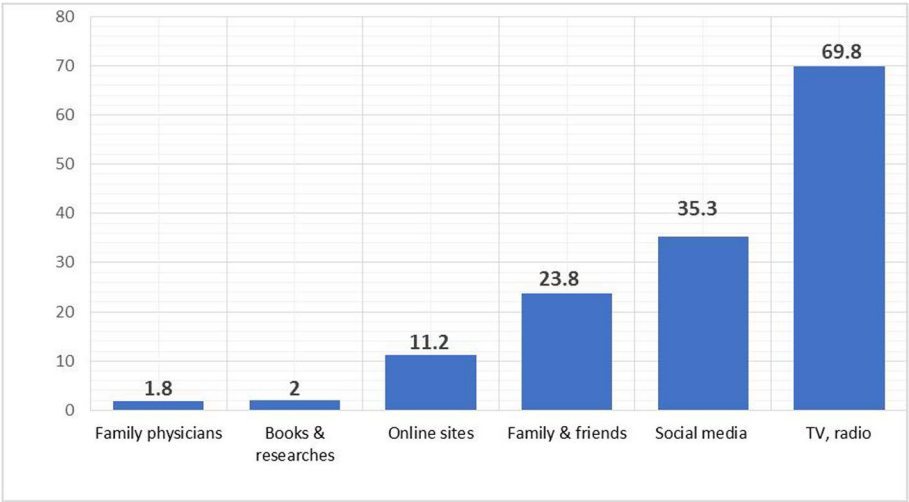

Fig. 1 Sources of information of the study participants about COVID-19 vaccination

Table 3 Sociodemographic characteristics of studied children

Variable ($n = 527$)		N (%)
Child age (years)	Mean ± SD Median (min- max)	6.9 + 3.1 6.0 (3.0–12.0)
Child sex	Female	211 (40.0%)
	Male	316 (60.0%)
Child previous infection with SARS-CoV-2	Yes	33 (6.3%)
	No	405 (76.9%)
	Not sure	89 (16.9%)
Child chronic disease	• Rheumatic & immunogenic	52 (9.9%)
	• Motor disability	14 (2.7%)
	• Respiratory diseases	467 (88.6%)
	• Diabetes mellitus	18 (3.4%)
	• Neuropsychiatric disorders	45 (8.5%)
	• Renal & hepatic diseases	93 (17.6%)
	• Hypertension	5 (0.9%)
	• Cardiac disease	37 (7.0%)
	• Auditory & hearing loss	9 (1.7%)
	• Gastrointestinal diseases	6 (1.1%)
	• Others	3 (0.6%)
Child received compulsory vaccination	Yes	458 (86.9%)
	No	63 (12.0%)
	Not sure	6 (1.1%)
Child flu vaccination	Yes	119 (22.6%)
	No	358 (73.1%)
	Not sure	23 (4.4%)

SARS-CoV-2 Severe acute respiratory syndrome coronavirus 2

Sinovac (1.7%), Sinopharm (12.1%), Moderna (0.9%) were the preferred vaccines. Of the participants, 59.6% were unsure of the type of vaccine (Fig. 2).

Study participants' characteristics across intention to vaccinate children variables.

As shown in the bivariate analysis, the site of data

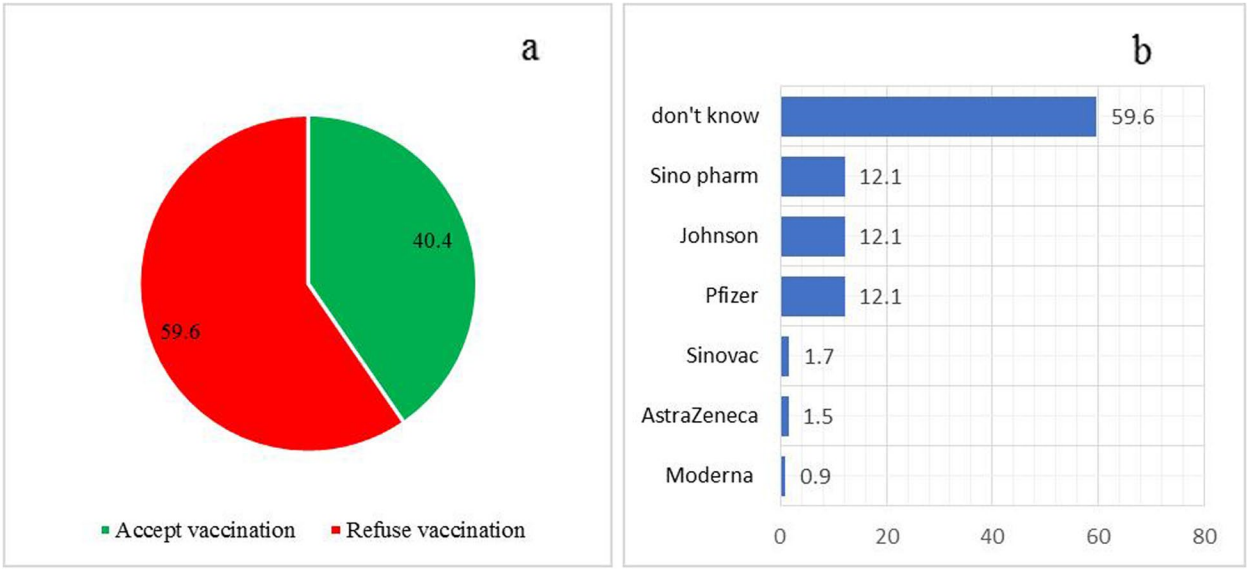

Fig. 2 **a** Parental attitude about vaccination of children against COVID-19 (**b**) preferred type of vaccine

collection was significantly associated with PACV score, with AMUH Hospital showing a statistically significant higher PACV score, (median = 43.33) compared to Al-Galaa Hospital or Menoufia Hospital as seen in the pairwise comparative data analysis (Supplementary file S2), $p < 0.001$. Residence influenced the intention of vaccination, particularly for individuals from Behira (PACV medians = 43.33) compared to those from Cairo, Alexandria and Giza, $p < 0.022$, $p < 0.007$, $p < 0.015$ respectively. Occupational and education were significantly associated with parental attitude towards vaccination. Governmental employees had lower PACV (median = 26.67) compared to those who worked in the private sector and were not employed (median = 36.67, 36.67, $p < 0.001$). Higher parental education level was associated with a lower PACV score, especially higher education (PACV median = 36.67) compared to university education (PACV median = 33.33, $p < 0.036$). Participants with governmental health insurance had the lowest PACV (median = 26.67) compared to those with the uncovered category (median = 36.67), this deference was statistically significant ($p < 0.001$). Distinct vaccination intention was evident between health and non-health sector workers (median PACV was 26.67 vs 36.67 respectively, $p = 0.032$). Furthermore, income groups also showed varying intentions to vaccinate their children, higher income level was significantly associated with lower PACV ($p < 0.001$). Previous COVID-19 status was significantly associated with PACV score. Participants who were "not sure" showing distinct intention (PACV median = 40.00) from "yes" (PACV medians = 33.33), $p < 0.037$. Equally important, various COVID-19 vaccine statuses yielded varying intentions, with those who "Refusal vaccination" (PACV median = 40.00), vs "Took the first and second doses and is awaiting the booster dose" (median = 30.00), "Took the first dose and is awaiting the second" (median PACV = 30.00), and who "Took the three doses" (median PACV = 33.33), $p < 0.001$. While not statistically significant, there's a subtle variation in intent between participants with female (median PACV = 33.33) and male children (median PACV = 36.67), $p = 0.101$. Furthermore, although not statistically significant ($p = 0.091$), slight intention differences appeared among various child history of previous COVID-19 infection. Finally, the presence of respiratory disease in children had a statistically significant association with hesitation to vaccination among parents (PACV median = 36.67 vs 33.33, $p = 0.017$) (Table 4). The supplementary file (S2) contains the post-hoc analysis of the significant findings.

Predictors of PACV score

Multiple linear regression was used to test if the following variables [health care worker, age, governorate, setting, education, working, health insurance, income, elderly presence, previous COVID 19, COVID-19 vaccine status, child vaccination against seasonal influenza, and the number of children in the household] significantly predicted [PACV score]. Overall, regression was statistically significant ($R^2 = 0.31$, $p < 0.01$). The predictors of the PACV score were governorate, Menoufia (β = 11.30, 95%CI [5.32, 17.27], $p < 0.001$), study setting, Menoufia University Hospital

Table 4 Participants' characteristics across intention to vaccinate children variables

Studied variables	Level	PACV		P
		N	Median (IQR)	
Age (years)	18–29	104	36.67(6.67–70.00)	**0.587 K**
	30–39	292	36.67(6.67–86.67)	
	40–49	106	36.67(6.67–80.00)	
	50–59	23	36.67(6.67–73.33)	
	> 60	2	25.0(20.00–30.00)	
Hospital where data collected	El-Raml Hospital	140	33.33(6.67–70.00)	**0.0001* K**
	Al-Galaa Hospital	140	35.0(6.67–70.00)	
	Menoufia Hospital	100	30.0(6.67–73.33)	
	AMUH Hospital*	147	43.33(13.33–86.67)	
Residence	Cairo	57	33.33(10.00–63.33)	**0.01* K**
	Alexandria	253	33.33(6.67–86.67)	
	Giza	81	33.33(6.67–56.67)	
	Behira	61	43.33(6.67–70.00)	
	Menoufia	61	36.67(6.67–73.33)	
	Others	14	45.0(20.00–83.33)	
Relation to the Child	Mother	430	36.67(6.67–76.67)	**0.195 K**
	Father	67	36.67(6.67–86.67)	
	Other	30	40.0(6.67–70.00)	
Number of chronically diseased children in the family	1	450	36.67 (6.67–86.67)	**0.456 K**
	2	63	33.33 (6.67–70.00)	
	≥ 3	14	38.33(23.33–70.00)	
Education	High school or below	406	36.67(6.67–83.33)	**0.041* K**
	University Degree	109	33.33(6.67–86.67)	
	Postgraduate degree	12	31.67(10.00–76.67)	
Occupation	Government	77	26.67(6.67–76.67)	**0.0001* K**
	Private	89	36.67(10.00–66.67)	
	Not Employed	361	36.67(6.67–86.67)	
Employment	Work from home	29	33.33(10.00–60.00)	**0.08 K**
	Part-time	19	33.33(13.33–66.67)	
	Full Time	124	33.33(6.67–80.00)	
	Not Employed	355	36.67(6.67–86.67)	
Health insurance	Government	92	26. 67(6.67–76.67)	**0.0001* K**
	Private	20	35.00(10.00–70.00)	
	Uncovered	415	36.67(6.67–86.67)	
Work sector	Non-Health	493	36.67(6.67–86.67)	**0.032* U**
	Health	34	26.67(10.00–76.67)	
Monthly income	Not enough, on a loan and cannot pay back	80	40.0(10.00–73.33)	**0.0001* K**
	Not enough, on a loan but can pay back	195	40.00(6.67–83.33)	
	Enough	242	33.33(6.67–86.67)	
	Enough and save	10	33.33(6.67–50.00)	
Older adults living in the household	No	323	33.33(6.67–86.67)	**0.002* U**
	Yes	204	40.00(6.67–83.33)	
Size of family	1–3	30	38.33(6.67–86.67)	**0.079 K**
	4- 5	356	36.67(6.67–83.33)	
	> 5	141	40.00(6.67–76.67)	
Previous COVID 19	Yes	158	33.33(6.67–76.67)	**0.037* K**
	No	250	36.67(6.67–86.67)	
	Not sure	119	40.00(6.67–73.33)	

Table 4 (continued)

Studied variables	Level	PACV		P
		N	Median (IQR)	
COVID-19 vaccine status	Took the three doses	58	33.33(10.00–76.67)	**0.0001* K**
	Does not want to take the vaccine	149	40.0(6.67–86.67)	
	Wants to take the vaccine, but it is not scheduled yet	38	40.0(6.67–66.67)	
	Took the first and second doses and is awaiting the booster dose	114	30.00(6.67–70.00)	
	Took the first and second doses but did not want to take the booster dose	86	33.33(6.67–60.00)	
	Took the first dose and is awaiting the second	41	30.00(10.00–50.00)	
	Took the first dose but does not want to take the second dose	41	43.33(6.67–70.00)	
Child sex	Female	211	33.33(6.67–86.67)	**0.101 U**
	Male	316	36.67(6.67–83.33)	
Child history of SARS-CoV-2 infection	Yes	33	30.00(6.67–86.67)	**0.091 K**
	No	405	36.67(6.67–83.33)	
	Not sure	89	36.67(6.67–76.67)	
Children with respiratory disease	Yes	256	33.33(23.33–43.33)	**0.017* U**
	No	271	36.67(26.67–46.67)	

K Kruskal–Wallis Test, *U* Mann–Whitney

* Significant $p < 0.05$

(β = -20.07, 95%CI [-25.40, -14.75] and El-Raml Hospital (β = -10.74, 95%CI [-14.50, -6.98], $p < 0.001$), income; not enough loans repaid (β = 3.18, 95%CI [0.54, 5.82], $p = 0.018$) and not enough loans not repaid (β = 3.57,95%CI [0.08, 7.07], $p = 0.045$). The variable "COVID-19 vaccination status" indicates that various categories had significant effects on the outcome. For example, taking the "first and second doses and awaiting the booster dose" (β = -9.54, $p < 0.001$) and "three doses" (β = -8.31, $p < 0.001$) had significant negative impacts on the PACV compared to the reference category (Table 5).

Discussion

With few therapeutic options for COVID-19, vaccine development has been accelerated around the world. COVID-19 vaccines are a major public healthcare achievement of the twenty-first century, and vaccines have apparently decreased the disease's severity and progression. However, the success of COVID-19 vaccines is dependent on herd immunity. VH has been identified as a major impediment to achieving herd immunity. This study examined parents' intentions to vaccinate their children with chronic diseases aged 3.0 to 12.0 years old, as well as the contributing sociodemographic, health-related, and behavioral factors.

Main study findings

A survey revealed that 59.6% of the respondents refused COVID-19 vaccination for their child, while 40.4% accepted it. The preferred vaccines were AstraZeneca, Pfizer, Johnson, Sinovac, Sinopharm, and Moderna. Information on COVID-19 vaccination was obtained from various sources, including family, friends, social networks, television, radio, books, online websites, and family physicians. Multilinear regression model showed that factors such as study location, governorate, income, parental COVID-19 vaccine status significantly influenced the PACV score.

Interpretation of the main study findings

We found that almost two-thirds of parents (59.6%) refused to vaccinate their children despite 11.0% of the parents surveyed having completed their vaccination schedule (received the primary series and booster vaccine). In a similar vein, numerous studies conducted in Egypt have reported low COVID-19 vaccination rates among children [24, 26]. Reports from Egypt revealed that vaccination coverage among individuals aged over 5 years was comparatively low, with only 14.0% of the population receiving booster doses. This percentage was significantly lower than the global vaccination coverage, which is reported at 31.4% [27]. A study conducted at the National Liver Institute in Egypt found that 81.5% of parents of children with chronic liver disease hesitated to

Table 5 Multivariate analysis of the predictors of PACV score

Variables		β	Ci	Error	t	P
	(Intercept)	**34.57 *****		**9.79**	**3.53**	
Health care worker	No	(R)				**0.629**
	Yes	-1.11	[15.33, 53.81]	2.88	0.39	
Age	18–29	2.52	[-15.91, 20.94]	9.38	0.27	**0.788**
	30–39	4.67	[-13.61, 22.95]	9.3	0.50	**0.616**
	40–49	5.04	[-13.33, 23.40]	9.35	0.54	**0.59**
	0–59	3.42	[-15.48, 22.33]	9.62	0.36	**0.722**
	> 60	(R)				
Governorate	Behira	0.55	[-3.57, 4.68]	2.1	0.26	**0.791**
	Cairo	5.64	[-13.76, 25.04]	9.87	0.57	**0.568**
	Fayoum	11.35	[-13.37, 36.06]	12.58	0.90	**0.367**
	Giza	4.3	[-15.09, 23.70]	9.87	0.44	**0.663**
	Kafr El-Shikh	3.33	[-6.02, 12.69]	4.76	0.70	**0.484**
	Matrouh	3.42	[-22.43, 29.27]	13.16	0.26	**0.796**
	Minya	15.99	[-10.92, 42.90]	13.7	1.17	**0.244**
	Menoufia	11.30 ***	[5.32, 17.27]	3.04	3.72	**0.0002 *****
	Qena	2.04	[-30.76, 34.84]	16.7	0.12	**0.903**
Study setting	Al-Galaa Hospital	-14.6	[-34.37, 5.17]	10.06	-1.451	**0.147**
	El-Raml Hospital	-10.74 ***	[-14.50, -6.98]	1.91	-5.62	**3.29e-08 *****
	Menoufia Hospital	-20.07 ***	[-25.40, -14.75]	2.71	-7.41	**5.80e-13 *****
Education	Postgraduate	3	[-6.35, 12.35]	4.76	0.63	**0.529**
	University graduate	2.46	[-0.93, 5.86]	1.73	1.42	**0.155**
Occupation	Not working	4.64	[-1.51, 10.79]	3.13	1.48	**0.139**
	Private sector	2.37	[-3.91, 8.64]	3.19	0.74	**0.459**
Health Insurance	Private	5	[-2.84, 12.84]	3.99	1.25	**0.21**
	Uncovered	2.38	[-3.21, 7.97]	2.85	0.84	**0.404**
Income	Enough and save	3.27	[-5.59, 12.14]	4.51	0.73	**0.469**
	Not enough loans repaid	3.18 *	[0.54, 5.82]	1.34	2.37	**0.018 ***
	Not enough loans not repaid	3.57 *	[0.08, 7.07]	1.78	2.01	**0.045 ***
Elderly living in the same context	Yes	1.16	[-1.53, 3.84]	1.37	0.85	**0.398**
Previous SARS-CoV-2 infection	Not sure	2.65	[-0.25, 5.55]	1.48	1.79	**0.074**
	Yes	1.86	[-1.02, 4.74]	1.46	1.27	**0.205**
COVID19 vaccine status	Took the first and second doses and is awaiting the booster dose	-9.54 ***	[-12.86, -6.21]	1.69	-5.64	**2.94e-08 *****
	Took the first and second doses but did not want to take the booster dose	-5.43 **	[-9.09, -1.77]	1.86	-2.91	**0.003 ****
	Took the first dose and is awaiting the second	-6.73 **	[-11.25, -2.21]	2.3	-2.93	**0.004 ****
	Took the first dose but does not want to take the second dose	1.77	[-3.04, 6.59]	2.45	0.72	**0.47**
	Took the three doses	-8.31 ***	[-12.57, -4.06]	2.166	-3.84	**0.0001 *****
	Wants to take the vaccine, but it is not scheduled yet	-3.88	[-8.63, 0.87]	2.42	-1.6	**0.11**
Child received seasonal flu vaccination	Not sure	-5.04	[-10.69, 0.61]	2.88	-1.75	**0.081**
	Yes	-1.26	[-4.08, 1.56]	1.44	-0.88	**0.382**
Number of children in the household	2	-1.71	[-13.08, 9.67]	5.79	-0.30	**0.768**
	3	3.13	[-2.68, 8.94]	2.96	1.06	**0.291**
	4	-1.32	[-4.87, 2.24]	1.81	-0.73	**0.466**
	> 5	0.22	[-2.90, 3.34]	1.59	0.139	**0.89**

[*] $N = 527$, R2 = 0.31; All continuous predictors are mean-centered and scaled by 1 standard deviation

[***] $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

vaccinate their children [26]. Another study conducted in Egypt found that 70.0% of parents of children with cerebral palsy were hesitant to administer the COVID-19 vaccine [24]. On the other hand, Drouin et al. [28] reported a higher intention of parents (64.0%) to vaccinate asthmatic children in Saudi Arabia. The low coverage of COVID-19 vaccination in Egypt may be attributed to uncertainty about vaccine effectiveness, lack of trust in vaccine due to rapid vaccine production, lack of information, and concern about vaccine side effects [29, 30]. An additional explanation from a psychological perspective, particularly involving beliefs in conspiracy theories, points to a fear of infertility as one of the side effects of vaccination among the population residing in the Middle East region [31, 32]. Despite some parents' hesitancy, it is promising to see that the majority of parental concerns focused on the vaccine's safety and efficacy. These concerns can be addressed to some extent by time and announcing the pharmacovigilance reports concerning the vaccination of children, which are expected to show high safety and efficacy in children.

Determinants of vaccination hesitancy

Sociodemographic factors

In our study, we found that several socioeconomic variables, including parents' residence, level of education, working sector, and a previous history of infection with COVID-19; had a significant impact on parents' willingness to vaccinate their children. However, factors like gender of the respondents and age were not significant in bivariate or multivariate analysis. These significant factors could be explained by a spike in anxiety, depression, and stress during the pandemic [33]. Furthermore, in bivariate analysis, parents who had elderly family members living with them at home were more likely to express hesitancy. Interestingly, this variable was not significant in multivariate analysis. This hesitancy may be due to their concerns about their elders' well-being and their heightened vulnerability to infections resulting from age-related changes in the immune response [34].

Several studies have shown that parental VH is influenced by their monthly income [20, 35, 36]. In the current study, income level was significantly associated with PACV score in bivariate and multivariate analysis. Parents in our study whose income was not enough and who tend to get unrepaid loans had 3.57 times higher PACV score compared to those who had enough income. In research conducted among parents of children aged 5 to 11 years in Saudi Arabia, those with a monthly household income of more than 10,000 Riyal were significantly more likely to vaccinate their children against COVID-19 [37]. Other studies in the United States, England, and Bangladesh supported this finding [20, 35, 36].

Parents' vaccination status

In the current work we found that vaccination of parents against COVID-19 significantly decreased the PACV score, almost 10 times more than those who were not vaccinated. Likewise, Choi et al. [38] indicated that the Chinese population who completed their vaccination program had a higher intention to vaccinate their children. Elkhadry et al. [26] reported that parents' trust had a direct negative association with their reluctance to vaccine children. Furthermore, Durmaz et al. [39] found that Parents who are VH, as determined by the PACV scale, have a less positive attitude toward the COVID-19 vaccine.

These theories met the debates about the safety margin of specific types of vaccination, such as mRNA vaccines [40]. Plenty of adverse events following immunization (AEFI) have developed. The Uppsala Monitoring Centre for pharmacovigilance recorded 2.9 million reports during 2021 and an additional 1.7 million reports in 2022 [41]. Despite evidence argue the safety of mRNA vaccine on the human fertility and maternal health [40, 42, 43]. In the last two years, Mansour et al. [44] reported menstrual irregularities in women subsequent COVID-19 vaccination with poorly understood mechanisms. Eslait-Olaciregui et al. [45] indicated that COVID-19 vaccinations has an epidemiological linkage to neurological disorders such as cerebral venous sinus thrombosis, stroke, convulsions, Guillain-Barré syndrome, facial nerve palsy, and other neurological diseases. Khalid et al. [46] reported high rates of anaphylaxis to the mRNA vaccines in young to middle-aged females. COVID-19 vaccination was also associated with higher risks of multisystemic inflammatory syndrome in children (MIS-C), myocarditis, and pericarditis in adults and children [47–50]. As a result, health authorities should proactively develop intervention programs aimed at delivering health messages through widely used communication channels to reassure parents about the safety and effectiveness of COVID-19 vaccination. Decision-makers need to actively combat rumors and address infodemics that could potentially influence parents' attitudes toward vaccination.

Strengths and limitations

This study offers numerous strengths that contribute to its quality and reliability. First, to our knowledge, this is the first study to assess VH in children with different chronic diseases in Egypt. Second, conducting the study multicentrally and at different socioeconomic levels supports its external validity. Finally, using valid questionnaire and random sampling method allows the generalization of the findings and provides robust evidence. However, there are a few limitations to consider in our study. First, the cross-sectional design of the study made

it not accessible to measure causality between the variables studied, more cohort studies are required to detect changes in VH over time. Second, recall bias among respondents when remembering the vaccination history of their children may be present.

Conclusion

In conclusion, almost two-thirds of our sample were hesitant to vaccinate their children. Parents' willingness to vaccinate their children was significantly influenced by socioeconomic factors such as their parents' residence, level of education, working sector, and history of COVID-19 infection. That requires more attention from the decision-makers to pay attention to the causes of VH and point out the significance of awareness programs for parents and caregivers on the importance of vaccination campaigns to minimize the complications of SARS-CoV-2 disease in children with chronic diseases. In future research, the emphasis should be placed on community engagement initiatives that incorporate local leaders and family physicians to promote open discussion and build trust. In addition, interventions should be designed with income considerations, ensuring affordability and accessibility across all socioeconomic groups. Tailoring strategies to specific governorates are crucial for addressing region-specific concerns. Encouraging parental participation and using family networks can play a crucial role in increasing confidence in the vaccination process, thus contributing to increased rates of COVID-19 vaccination among children and fortifying broader public health efforts.

Supplementary Information

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Additional file 1.

Additional file 2.

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Authors' contributions

RMG: conceptualization of research idea, writing and reviewing the manuscript, SWE: data collection, statistical analysis, writing and reviewing the manuscript; EAH: coordination the study, data collection, writing and reviewing the manuscript, ESE: data collection, writing and reviewing the manuscript, MSAHM: Data collection and writing the manuscript. AAA: data collection. All authors have read and agreed to the published version of the manuscript."

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Availability of data and materials

The datasets used and/or analyzed during the current study are included in this published article.

Declarations

Ethics approval and consent to participate

The GOTHI Ethics Committee approved the current study (REC number HG00086). The Declaration of Helsinki was followed during the research's execution. All parents gave written, informed consent before to participation. After hearing the study's justification, the parents signed a formal consent form on behalf of their children. The involvement of the parents is entirely up to them. By coding the collected data, the privacy of the parents and their kids was safeguarded.

Consent for publication

Not applicable.

Competing interests

The authors declare no conflict of interest.

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