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REVIEW PAPER

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The fear of needles: A systematic review and meta-analysis

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Abstract

Aims: The aim of this study was to evaluate the prevalence of needle fear and summarize the characteristics of individuals who exhibit this fear.

Background: Injections are among the most common medical procedures, yet fear of needles can result in avoidance of preventive measures and treatment.

Design: Systematic review and meta-analysis.

Data Sources: MEDLINE (1966–2017), Embase (1947–2017), PsycINFO (1967–2017), and CINAHL (1961–2017) were searched, with no restrictions by age, gender, race, language, or country.

Review Methods: The prevalence of needle fear was calculated and restricted maximum likelihood random effects models were used for meta-analysis and meta-regression.

Results: The search yielded 119 original research articles which are included in this review, of which 35 contained sufficient information for meta-analysis. The majority of children exhibited needle fear, while prevalence estimates for needle fear ranged from 20-50% in adolescents and 20–30% in young adults. In general, needle fear decreased with increasing age. Both needle fear and needle phobia were more prevalent in females than males. Avoidance of influenza vaccination because of needle fear occurred in 16% of adult patients, 27% of hospital employees, 18% of workers at long-term care facilities, and 8% of healthcare workers at hospitals. Needle fear was common when undergoing venipuncture, blood donation, and in those with chronic conditions requiring injection.

Conclusions: Fear of needles is common in patients requiring preventive care and in those undergoing treatment. Greater attention should be directed to interventions which alleviate fear in high-risk groups.

KEYWORDS
anxiety, fear, injection, medical nursing, mental health, needle, phobia

1 | INTRODUCTION

Certain medical devices are so valuable in the practice of nursing and medicine that they are used worldwide. The hypodermic needle is one such device. It is employed for vascular, intradermal, subcutaneous, and intramuscular access and for biopsy and drug delivery across an extensive range of tissues (e.g., epidural, intraperitoneal). While routinely used in clinical settings such as hospitals and medical offices, hypodermic needles are also frequently used in community settings for public health purposes and in home settings for patients with disabilities.

Across these settings, it is often the nurse who administers injections or who draws blood. Indeed, these procedures are among the skills taught in nursing schools throughout the world (Altman, Wcisel,

& Kerestzes, 2010). Beyond the expertise required for the administration of injections, however, are the psychosocial aspects of such delivery which are experienced by the patient. Because fear of needles is one such emotion observed in some patients who may anticipate pain, we conducted a systematic review of the fear of needles to explore the prevalence of this condition.

1.1 | Background

In a World Health Organization study of 10 major regions in the world, the mean frequency of needle injections ranges from 2-11 per person each year (Hutin & Chen, 1999). Such injections are among the most common medical procedures, integral for both for preventive and treatment purposes. Yet, the fear of needles can delay or result in avoidance of preventive measures such as vaccination and may also deter blood donation, venipuncture during routine clinical evaluation and necessary treatment for various acute and chronic conditions (Wright, Yelland, Heathcote, Ng, & Wright, 2009).

The terms "needle fear" and "needle phobia" both describe anxiety associated with needles and situations where needles or injections are used. However, needle phobia, as defined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), is a more extreme psychiatric disorder than generalized fear and often involves visual avoidance of the phobic stimulus and a diphasic vasovagal response featuring an initial increase and subsequent precipitous decrease in blood pressure, which can result in fainting (Jenkins, 2014). Needle phobia *per se* occurs less often than the generalized fear or anxiety associated with needles (Wright et al., 2009). Classical conditioning based on shared negative experiences of painful procedures may also invoke needle fear or phobia (Jenkins, 2014).

While fear may be acknowledged in practice, the extent of needle fear and the characteristics of persons affected have not yet been fully described. A better understanding of this condition may enable efforts to develop interventions to alleviate fear so that necessary procedures can be undertaken.

Why is this research or review needed?

- Patients often express a fear of needles or injection.
- Because the use of needles is ubiquitous in clinical settings, it is important to understand who is at higher risk of needle fear and the consequences of needle fear.

What are the key findings?

- Children exhibited the greatest fear of needles and the prevalence decreased with age.
- Women have greater needle fear than men, across all countries studied.
- Approximately one in six healthcare workers in long-term care facilities and 1 in 13 healthcare workers in hospitals avoided influenza vaccination because of the fear of needles.

How should the findings be used to influence policy/practice/research/education?

- Greater attention should be given to evidence-based approaches to alleviate fear during injections.
- Although some nonneedle options are available, there is a need to expand possible nonneedle alternatives for vaccination, fluid administration, and drug delivery.

2 | THE REVIEW

2.1 | Aims

This systematic review was conducted to: (a) assemble the body of literature available regarding the prevalence of needle fear and phobia; (b) summarize the prevalence of needle fear and phobia across demographic and clinical factors; and (c) assess the degree of vaccination avoidance because of needle fear.

2.2 | Design

A systematic review and meta-analysis were performed using established guidelines for observational research (Joanna Briggs Institute, 2015; Rogers, 2014; Stroup et al., 2000) and the general procedures outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). The investigation was registered in PROSPERO, the International Prospective Register of Systematic Reviews (CRD42017070595).

2.3 | Inclusion/exclusion criteria

Eligibility criteria were: (a) scientific publication of original research; (b) fear or phobia of needles was investigated in the study; (c) data were included regarding the frequency of needle fear; and (d) the study was conducted in humans. We included articles that assessed fear of needles in general and the blood–injection–injury subtype of phobia as classified by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV).

2.4 | Search methods

Data emanated from original research studies in which there were data regarding fear of needles. The bibliographic databases searched were Medical Literature Analysis and Retrieval System (MEDLINE, 1966-6/21/2017), Excerpta Medica dataBASE (Embase, 1947-6/21/2017), PsycINFO (1967-6/21/2017), and Cumulative Index to Nursing and Allied Health Literature (CINAHL, 1961-6/21/2017). There were no language restrictions nor were there restrictions by age, gender, race, or country of origin. The search terms included Boolean logic and controlled vocabularies to retrieve terms such as "injections" (MeSH Major Topic) and "needles" (MeSH Major Topic);

the search strategy is listed in Appendix Table S1). We also conducted first-level backward chain searching of review articles on needle fear (i.e., evaluation of review articles for information regarding original studies).

2.5 | Search outcome

Of the databases searched, there were 559 records retrieved and 357 records screened (Figure 1). Of the 227 full text articles assessed for eligibility, 119 satisfied eligibility criteria for this review. Study eligibility was ascertained independently by each author after review of the title and abstract. Differences in eligibility were flagged and resolved through discussion. This was followed by an independent review of eligibility by each author based on the entire research article. Reasons for exclusion were: (a) not an original research study (N = 52), (b) prevalence of needle fear was not given (N = 42), and (c) the study did not examine needle fear (N = 14). Of the 119 studies included in this review, there were 35 articles that contained sufficient information to allow either meta-analysis of a summary measure or meta-regression.

2.6 | Quality appraisal

As the outcome of interest was prevalence, quality assessment was evaluated using epidemiologic standards established for accurate assessment of prevalence (Rothman, Greenland, & Lash, 2012) and international standards for survey research (De Leeuw, Hox, & Dillman, 2012). The criteria were: (a) the response rate; (b) the use of population-based representative sampling; (c) employing a random sample of the target reference group; and (d) whether a standardized instrument was used to assess needle fear or phobia. Each of the four elements was determined independently by the two authors; when there was disagreement after review, the original article was reviewed for clarity.

2.7 | Data abstraction

Data regarding study characteristics (e.g., first author, year of publication, location), study sample (e.g., age, gender, disease/condition), how fear/phobia was assessed, and prevalence of fear were independently extracted by each author. Differences were resolved through discussion.

2.8 | Synthesis

The prevalence and 95% exact confidence intervals were calculated for each study. Data were grouped according to the specific type of outcome measured (fear, phobia) and by personal characteristics (e.g., gender, occupation). Heterogeneity was evaluated by using I^2 (inconsistency index) and τ^2 (between-study variance). For results that were heterogeneous (where a summary measure could not be pooled), data were plotted and meta-regression was performed. In meta-regression, between-study variance was modelled using random effects restricted maximum likelihood and p-values and confidence intervals were calculated using the Knapp–Hartung method. To pool prevalence, a restricted maximum likelihood random-effects model was used in meta-analysis and the Freeman–Tukey arcsin transformation was applied. Alpha was set at 0.05 (two-tailed) and results were conducted in Stata/MP 15.1 (College Station, TX).

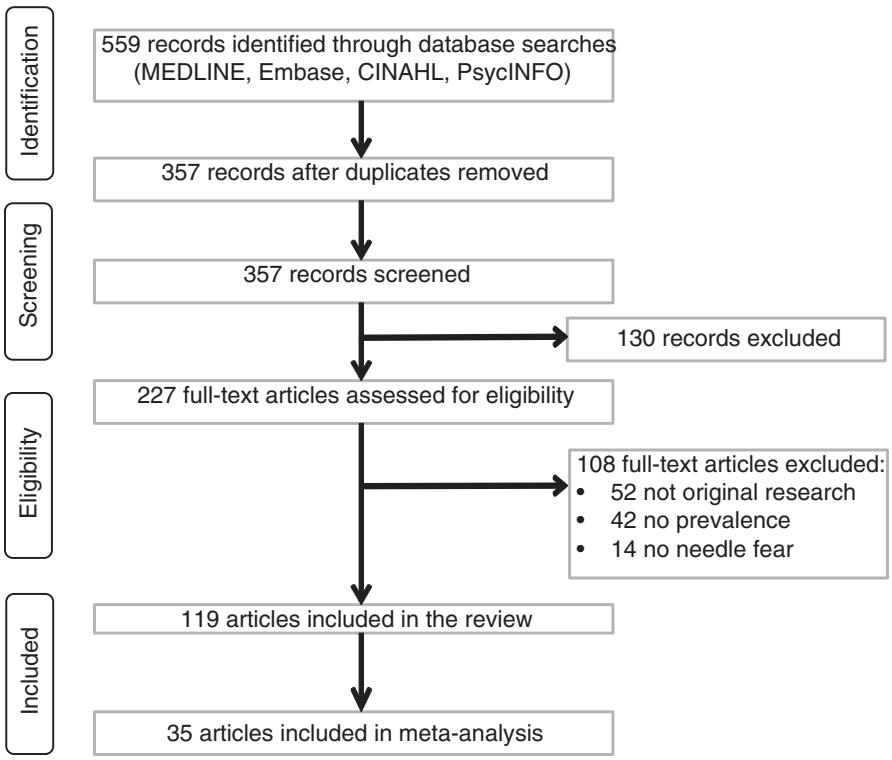

FIGURE 1 Flow diagram of eligible studies

3 | RESULTS

3.1 | Overall characteristics of the studies

The 119 eligible publications ranged from large population-based national surveys to small clinical studies (Appendix Table S2). The clinical studies generally included patients in whom injections were frequent such as children with type 1 diabetes and patients receiving routine dental procedures. There were also large population-based studies from several countries, including Australia, Germany, India, Mexico, the Netherlands, South Korea, Sweden, and the United States.

In quality assessment, 36 of the 119 eligible studies (30%) had response rates >80% (Appendix Table S3). Thirty studies involved a population-based sample and 22 extracted random samples from a targeted reference group. Of the 119 studies, 74.8% involved the use of standardized instruments to assess fear or phobia.

3.2 | Prevalence by age

There was considerable variation in the fear of needles by age (I^2 = 99.9%, τ^2 = 0.08). Fear of needles was greatest in children, especially younger children and decreased with age (Figure 2). The results of meta-regression indicated that, for every decade increase in age (years), there was an 8.7% (95% CI: 6.0%, 11.4%) decrease in the prevalence of needle fear ($p < 0.001$). The majority of children exhibited a fear of needles, while prevalence estimates ranged from 20-50% in adolescents. For adults who were 20–40 years, the prevalence of needle fear approximated 20-30%. It is noticeable that this prevalence dropped appreciably with older age and was <5% at the oldest ages.

3.3 | Prevalence by gender

For both needle fear and needle phobia, the prevalence was greater in girls than boys and was greater in women than men. For studies that reported prevalence in both genders, the results were graphed by gender and the female:male prevalence ratio was calculated (Appendix Figure S1). In each of the studies, the point estimate was greater in females than males. For needle fear, the pooled female:male prevalence ratio was 1.4 (95% CI: 1.1, 1.8) with I^2 of 89.8% and τ^2 of 0.067. For needle phobia, the pooled female:male prevalence ratio was 1.7 (95% CI: 1.3, 2.1) with I^2 of 63.4% and τ^2 of 0.038.

Gender differences in the prevalence of needle fear were evident across countries (Appendix Figure S1). Even with the gender differences, there was considerable heterogeneity in prevalence across countries. Needle fear was particularly high in Saudi Arabia and Israel, but quite low in Sweden. For needle phobia, Mexico and India had greater prevalence, while South Korea and Germany had low levels.

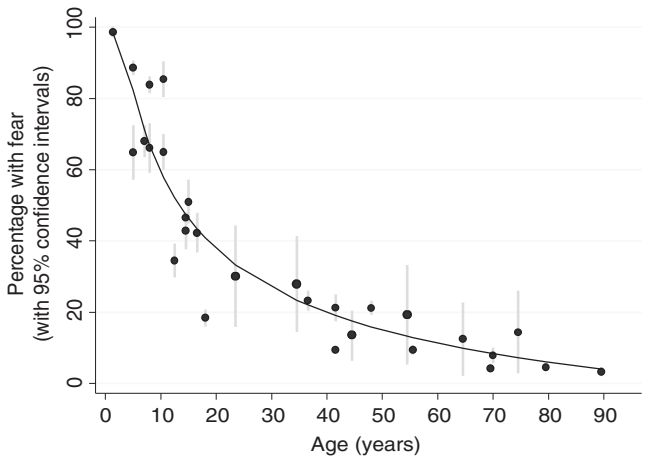

FIGURE 2 Fear of needles by age

3.4 | Prevalence by disease/condition

Many of the investigations reported fear of needles in patients with specific diseases or conditions. The results are shown in Table 1, with prevalence ranked within categories. Most of the studies were conducted in populations where injections were necessary for treatment. These included patients with cancer undergoing chemotherapy (prevalence of fear ranged from 15.7-84.0%), individuals with diabetes (prevalence ranged from 1.3-41.7%) and persons undergoing routine dental procedures (prevalence of fainting 1.7%; prevalence of needle fear from 11.7-91.0%). The prevalence of needle fear was also considerable for those with allergies, asthma, multiple sclerosis, spinal conditions, psychiatric disorders, and those undergoing dialysis. There was also high prevalence of needle fear when people were surveyed in various settings such as primary care clinics and in the hospital and in people who donate blood or who were planning to travel and required vaccination.

3.5 | Avoidance of medical procedures due to fear of needles

The results showed evidence of vaccination avoidance for influenza because of the fear of needles or injections (Figure 3). The prevalence of avoidance due to fear was 27% in hospital employees, 18% in healthcare workers at long-term care facilities (I^2 = 0.0%, $\tau^2 < 0.001$), 8% in healthcare workers at hospitals (I^2 = 23.8%, τ^2 = 0.001), 16% in adult patients (I^2 = 0.0%, $\tau^2 < 0.001$), and 6% in older adult patients (I^2 = 41.1%, τ^2 = 0.002).

Results were similar for avoidance of other vaccines. In a nationally representative sample of US adults, 19% did not obtain a pneumococcal vaccination and 20% did not obtain a tetanus vaccination because of dislike of needles (Johnson, Nichol, & Lipczynski, 2008). In a survey of 100 US physicians, 71% indicated that fear of needles was a contributing factor to not obtaining a tetanus vaccination; the figures were 71% and 69% for influenza vaccination and pneumococcal vaccination, respectively (Johnson et al., 2008). In a nationally representative survey of individuals 65 years and older in the US, 2.6% did not obtain a pneumococcal vaccination because the person "didn't like shots or needles" (Centers for Disease Control and Prevention (CDC), 1999).

TABLE 1 Prevalence of needle fear or phobia by disease and clinical setting

Category	First author	Year of publication	Prevalence	95% confidence interval		Description of injection fear or phobia
Conditions/Disease:						
Allergy:						
	Ferreira	2013	11.0%	6.8%	15.2%	Fear of allergy shots
Asthma:						
	De Vos	2012	77.8%	58.6%	97.0%	Injection fear in children starting immunotherapy
Cancer:						
	Kettwich	2007	84.0%	69.6%	98.4%	Needle phobia of syringe. Children undergoing chemotherapy
	Kettwich	2007	68.0%	49.7%	86.3%	Needle phobia of butterfly needle. Children undergoing chemotherapy
	Kettwich	2007	64.0%	45.2%	82.8%	Needle phobia of syringe. Adults undergoing chemotherapy
	Kettwich	2007	52.0%	32.4%	71.6%	Needle phobia of butterfly needle. Adults undergoing chemotherapy
	Cox	2007	41.0%	30.1%	51.9%	Would avoid future injections. Women with breast cancer with injection anxiety
	Cox	2007	37.5%	30.9%	44.1%	Injection anxiety in women with breast cancer
	Harris	2009	16.9%	10.8%	24.7%	Patients with blood–injection–injury fear undergoing chemotherapy
	Carey	2005	15.7%	10.7%	20.8%	Fear of injections in patients undergoing intravenous chemotherapy
Dental Patients:						
	Naidu	2010	91.0%	85.4%	96.6%	Anxious of local anaesthetic injection in gum
	Taani	2001	82.6%	78.7%	86.5%	Fear of feeling the needle injected
	Taani	2001	82.1%	78.1%	86.0%	Fear of seeing the injection needle
	Earl	1994	81.0%	73.5%	88.5%	Preoperative anxiety regarding injection before third molar surgery
	Boyle	2010	78.0%	71.4%	84.6%	Fear of seeing the anaesthetic needle
	Doebling	2000	68.1%	59.3%	76.9%	Negative perception of getting an injection.
	Doebling	2000	54.1%	44.7%	63.5%	Negative perception of sight of needle.
	Elmore	2014	42.6%	32.6%	52.5%	Afraid of needle injection in mouth.
	Berggren	1992	37.0%	27.9%	46.1%	Fear of hypodermic needles in people with severe dental anxiety
	van Maanen	2009	35.2%	26.9%	44.1%	Fear using Dental Subscale of the Children's Fear Survey Schedule
	Crawford	2005	26.0%	22.9%	29.1%	Afraid of injections
	Elmore	2014	25.5%	16.7%	34.3%	Afraid of needle injection in arm
	VanWijk	2012	25.5%	19.9%	31.1%	High preinjection anxiety
	Milgrom	1997	18.9%	15.6%	22.6%	Fear of the pain of injection during dental procedures
	Vika	2006	16.5%	14.3%	18.7%	High fear of dental injection, 18 years of age
	Majstorovic	2004	16.0%	14.4%	17.6%	Needle phobia in children
	Kaakko	1998	14.7%	10.1%	19.2%	Would not go ahead with dental injection due to anxiety/fear
	Armfield	2010	13.8%	12.0%	15.5%	Fear of dental needles or injections
	Bajric	2015	11.7%	6.5%	18.8%	Dental fear and anxiety in healthy youth, ages 8, 12, and 15 years
	Vika	2008	11.3%	6.2%	16.4%	Avoidance of dentist because of injection phobia, 18 years of age
	Crawford	2005	8.0%	6.1%	9.9%	Cancelled dental appointments because of apprehension regarding injections
	Liddell	1998	7.8%	5.5%	10.2%	Injection as unpleasant dental procedure
	DeJongh	1998	5.5%	2.0%	8.9%	Injection phobia
	Milgrom	1997	4.6%	2.8%	6.9%	Avoid dental appointments because of fear of injections
	Vika	2006	1.7%	0.9%	2.5%	Fainted with dental injection, 18 years of age
Diabetes:						
	Zambanini	1999	41.7%	32.7%	50.8%	Troubled by more injections. Types 1 & 2 diabetes taking insulin
	Howe	2011	40.9%	20.4%	61.5%	Fear of injections. Type 1 diabetes in hospital at time of diagnosis

(Continues)

TABLE 1 (Continued)

Category	First author	Year of publication	Prevalence	95% confidence interval		Description of injection fear or phobia
	Feitosa	2013	38.5%	26.6%	50.3%	Fear of self-injection, pregnant women with diabetes at 27 weeks gestation
	Hanas	1997	34.2%	26.8%	41.6%	Phobia at the sight of a needle. Children and adolescents with type 1 diabetes
	Cemeroglu	2015	32.7%	25.2%	40.2%	Caregivers of children and adolescents with type 1 diabetes. Fear of injections or fear of infusion site changes for continuous subcutaneous insulin infusion
	Cemeroglu	2015	22.0%	13.9%	30.1%	Adolescents with type 1 diabetes. Fear of injections or fear of infusion site changes for continuous subcutaneous insulin infusion
	Zambanini	1999	13.9%	7.6%	20.2%	Avoid injections secondary to anxiety. Patients with types 1 & 2 diabetes taking insulin
	Simmons	2007	13.4%	6.0%	20.8%	Needle fear when I have to inject myself. Children with type 1 diabetes
	Feitosa	2013	12.7%	4.5%	20.9%	Fear of self-injection, pregnant women with diabetes at 37 weeks gestation
	Simmons	2007	11.1%	4.3%	18.0%	Needle fear when my mom/dad injects me. Children with type 1 diabetes
	Simmons	2007	10.0%	4.1%	15.9%	Needle fear when I have to test my blood glucose. Children with type 1 diabetes
	Howe	2011	9.5%	0.0%	22.1%	Fear of injections. Type 1 diabetes at 6–9 months postdiagnosis
	Hanas	1997	8.2%	3.9%	12.5%	Pronounced needle phobia. Children and adolescents with type 1 diabetes
	Simmons	2007	1.4%	0.0%	4.3%	Needle fear when my mom/dad tests my blood glucose. Children with type 1 diabetes
	Mollema	2000	1.3%	0.7%	1.9%	Diabetes patients. Severe fear of self injection. Higher range in population
Dialysis Patients:						
	Mulder	2013	55.3%	44.7%	65.9%	I try to avoid it when I have to inject myself
	Mulder	2013	41.2%	30.7%	51.7%	I try to avoid it at the moment that the nurse comes to insert the needle
	Mulder	2013	26.7%	17.2%	36.2%	I feel afraid when I have to inject myself
	Mulder	2013	25.9%	16.5%	35.3%	I feel afraid at the moment that the nurse comes to insert the needle
Multiple Sclerosis:						
	Mohr	2001	44.0%	34.3%	53.7%	"A lot" or "extreme" anxiety associated with injections
	Turner	2009	41.4%	31.2%	51.6%	"Thinking about injecting myself makes me nervous."
Pregnancy/Prenatal counselling:						
	Peters	1984	17.0%	9.6%	24.4%	High needle or amniocentesis concern/anxiety
	Lilliecreutz	2008	7.2%	5.9%	8.6%	Pregnant women with blood/injection phobia
Psychiatric:						
	Tompkins	2007	57.8%	42.2%	72.3%	Needle fear in women who were drug users
	Starcevic	1997	27.1%	16.4%	40.3%	Blood injection injury phobia in patients with panic disorder with agoraphobia
	Terra	2007	2.9%	0.0%	6.2%	Blood–injection–injury phobia
Spina bifida:						
	Royle	2008	19.0%	7.3%	30.7%	Injection anxiety
Spinal cord injury:						
	Royle	2008	10.0%	5.7%	14.3%	Injection anxiety

Noncompliance with immunization due to needle fear occurred in 8% of children and 7% of parents in a sample from Canada; moreover, the degree of noncompliance was positively associated with the degree of fear (Taddio et al., 2012). For patients in Australia attending a general practice clinic, 64.1% of those with needle fear indicated avoiding future flu vaccination and 30.8% would avoid future tetanus vaccination; this compared with 19.5% and 7.0% for those without needle fear, respectively (Wright et al., 2009). In these patients, needle fear was also associated with avoiding blood tests, avoiding pain relief and avoiding blood donation (Wright et al., 2009). In a study of Japanese children, 52.2% of those with needle fear were unwilling to receive a vaccine at baseline which decreased to 27.5% after a participatory educational event (Kajikawa, Maeno, & Maeno, 2014).

Avoidance of other medical procedures was also demonstrated. Fear of needles was associated with avoiding having one's blood drawn (Deacon & Abramowitz, 2006), avoiding insulin injections in patients with diabetes (Zambanini, Newson, Maisey, & Feher, 1999), avoiding undergoing amniocentesis while pregnant (Peters, 1984) and cancelling a dental appointment or avoiding a dentist (Crawford,

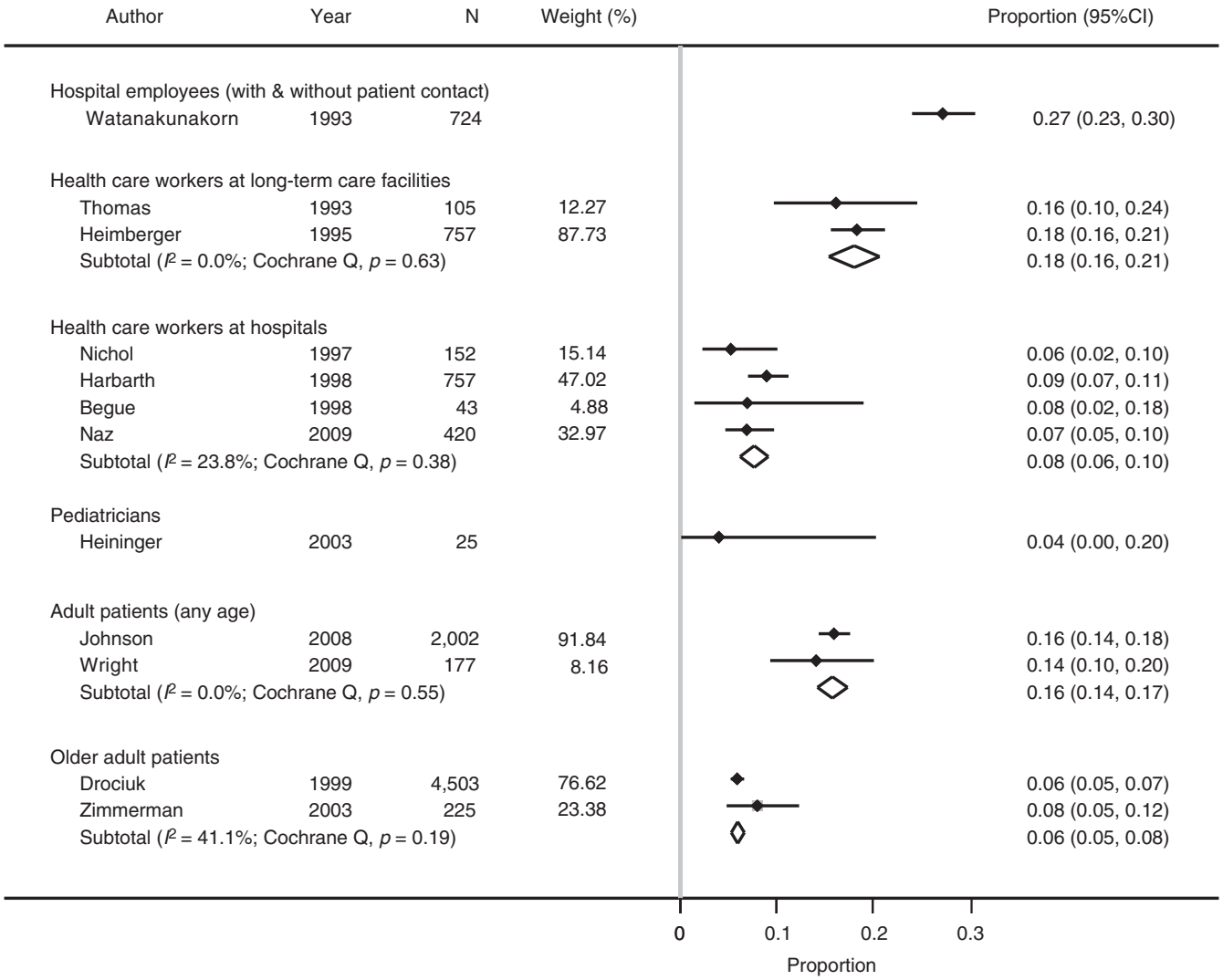

FIGURE 3 Forest plot of the proportion of individuals who avoided influenza vaccination because of needle fear

Niessen, Wong, & Dowling, 2005; Hakeberg & Berggren, 1997; Kaakko et al., 1998; Milgrom, Coldwell, Getz, Weinstein, & Ramsay, 1997; Vika, Raadal, Skaret, & Kvale, 2006).

4 | DISCUSSION

In this review, we found a significant variation in needle fear by age and gender. Young children and women exhibited higher prevalence of needle fear and phobia, regardless of country of origin. Throughout the world, women have largely taken the responsibility for their children's daily health concerns (World Bank, 2012). Even in developed countries, the vast majority of children's medical visits are handled by the mother (Daly & Groes, 2017). As vaccinations and medical procedures often involve needles, the fear of such needles by a disproportionate number of children and mothers could be an underrecognized impediment to preventive measures and treatment. Fadel et al. (2017) found that, in the United States, younger infants and infants with younger mothers were more likely to have received no vaccinations. The odds of infants having no vaccinations were five times greater in those with younger mothers (<20 years) compared to those with mothers ≥30 years of age (Fadel et al., 2017).

The degree of needle fear in patients who require injections due to the nature of their disease was striking. For example, 40.9% of children with type 1 diabetes were fearful of injections when they were first diagnosed in the hospital, although this declined to 9.5% at the third clinic visit which was 6–9 months after the initial diagnosis (Howe, Ratcliffe, Tuttle, Dougherty, & Lipman, 2011). Caregivers of patients with type 1 diabetes also reported fear of injections or fear of infusion site changes for continuous subcutaneous insulin infusion; this occurred in 32.7% of caregivers in one study (Cemeroglu et al., 2015). Moreover, they found that patients with type 1 diabetes who exhibited more fear had greater glycated haemoglobin levels. For some patients with long-standing type 1 diabetes, it may be difficult to discern whether the fear emanates from the injection itself or from anticipation of a hypoglycaemic event. Fear of self-injection for pregnant women with gestational diabetes was also

shown to be quite prevalent—38.5% at 27 weeks gestation (Feitosa, Sampaio, Batista, & Pinheiro, 2013).

Avoidance of preventive measures due to needle fear also occurred. We found that 8% of healthcare workers in hospitals and 18% of workers in long-term care facilities avoided influenza vaccination because of the fear of needles. There was also evidence of avoidance of vaccination for tetanus and pneumococcal disease (CDC, 1999; Johnson et al., 2008). Relatively small reductions in vaccine coverage have been shown to result in significant increases in disease cases with appreciable rises in public sector costs (Lo & Hotez, 2017). Healthcare worker vaccination leads to less staff absenteeism due to illness (Van Buynder et al., 2015) and greater nurse staffing levels have been associated with lower patient mortality (Aiken et al., 2014).

4.1 | Limitations

This review is limited by the inherent characteristics of the underlying original research articles. For population statistics, not all samples were randomly chosen and, for clinical samples, some involved referrals while others included a small number of participants. Authors often used different scales or types of questions for assessing fear and, therefore, there is a need for studies to determine the accuracy and reliability of such patient-reported outcomes and to develop a more unified approach to assessment so that prevalence can be compared across settings and cultures. Moreover, relevant technologies continuously change so that review and evaluation of patient outcomes using these devices require constant updating.

4.2 | Implications for future research and practice

While needle fear is occasionally mentioned as a contributor to vaccine hesitancy, there are relatively few studies designed to address this problem (Salmon, Dudley, Glanz, & Omer, 2015). There is a lack of applied public health and clinical research on methods of delivery which target factors such as needle size, injection speed, or nonneedle approaches (Noel et al., 2015). It is perhaps not surprising that a routine childhood vaccine that does not involve a needle has the highest rates of vaccination (i.e., polio vaccination rate = 93.7% in year 2015 in the United States) (National Center for Health Statistics, 2017). Approaches meant to reduce vaccine hesitancy target communication strategies for notification, reminders, or incentives but may not directly address the needle itself (Jarrett, Wilson, O'Leary, Eckersberger, & Larson, 2015). In a randomized trial, a needle-free jet injector was found to be noninferior to the usual needle delivery system for influenza vaccination (McAllister et al., 2014). Yet needle-free jet injectors are not in widespread use. Other examples of novel approaches to replace typical injection procedures include microneedles, mouth strips, nanopatches, mucosal administration, and edibles (Ravi, Sadhna, Nagpaal, & Chawla, 2015; Saroja, Lakshmi, & Bhaskaran, 2011). Such needle-free methods could also potentially reduce needlestick injuries which pose safety concerns in healthcare settings (Tarigan, Cifuentes, Quinn, & Kriebel, 2015).

There have been various approaches to confront the underlying fear. Because healthcare professionals sometimes underestimate patients' needle anxiety (Lidén, Olofsson, Landgren, & Johansson, 2012), improved assessment of symptoms may be necessary. There are guidelines for reducing pain during needle injections which is a reasonable starting point (Taddio et al., 2015). McMurtry et al. (2015) found that some psychological interventions targeted to needle fear and various muscle tension techniques to avoid fainting may provide benefits, although the quality of the evidence was low. Lilliecreutz, Josefsson, and Sydsjö (2010) conducted a trial in pregnant women who exhibited blood and injection phobia. In their study, cognitive behavioural therapy significantly reduced phobia and depressive symptoms. There is evidence that specific cognitive-behavioural interventions, hypnosis, and distraction (with nurse coaching) during an injection may lower distress in children and adolescents (Uman, Chambers, McGrath, & Kisely, 2008).

5 | CONCLUSION

In conclusion, fear of needles occurs frequently in populations throughout the world, with higher prevalence at younger ages and in women. Fear of needles is common in patients requiring preventive care and those undergoing treatment. Greater attention should be given to alleviate this fear with an ultimate goal of improving health. We recommend implementation studies of nonneedle approaches to standard needle injection, with direct application to public health and clinical settings. We also recommend randomized trials to assess specific cognitive and behavioural strategies to alleviate fear.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

AUTHOR CONTRIBUTIONS

All authors have agreed on the final version and meet at least one of the following criteria [recommended by the ICMJE (http://www.icmje.org/recommendations/)]:

- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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