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Systematic review: Effects of sustained nurse home visiting programs for disadvantaged mothers and children.

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Author contributions:

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Made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data;	CM, RB, CH, NP, SG
Involved in drafting the manuscript or revising it critically for important intellectual content;	CM, RB, CH, NP, SG
Given final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content;	CM, RB, CH, NP, SG
Agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.	CM, RB, CH, NP, SG

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ABSTRACT

Aims: To systematically evaluate published experimental studies of sustained nurse home visiting (SNHV) programs. This review summarizes the evidence and identifies gaps in the literature to inform practice, policy and future research.

Design: Restricted systematic review with narrative summary.

Data Sources: Databases searched were Medline, CINAHL, PsycINFO and Cochrane Central Register of Controlled Trials. Year of publication was originally restricted from 2008 to the date of search (13 February 2018, with supplementary searches conducted to identify more recent publications (up to 2019). Several reputable evidence clearinghouses were also searched.

Review Methods: Studies were included if they used a randomized or cluster-randomized controlled trial to evaluate a home visiting program that: (a) targeted disadvantaged mothers; (b) commenced during pregnancy or prior to the child's first birthday; (c) had an intended duration of at least 12 months from the time of enrolment; and (d) was substantively delivered by nurses or midwives. Meta-analyses and reviews of studies meeting these criteria were also included. A quality appraisal was conducted for all studies.

Results: Of 1393 total articles, 30 met inclusion criteria. Seven specific SNHV programs were identified. Each demonstrated evidence of a positive statistical effect on at least one child or maternal outcome.

Conclusion: SNHV programs benefit disadvantaged families, though effects vary across outcomes and subgroups. Further research is needed to discern the critical components of effective programs.

Impact: As sustained nurse home visiting programs have gained policy appeal, the need to evaluate the evidence-base supporting such interventions has become imperative. The findings of this review will assist policymakers and practitioners in high-income countries to make evidence-informed decisions about which programs are best suited to addressing specific maternal and child outcomes for disadvantaged families. This should in turn ameliorate some of the inequalities in child development that have significant social and economic costs.

Keywords: systematic review, nurses, midwives, home visiting, adverse childhood experiences, child health, maternal health, psychosocial development, parenting behavior

1 INTRODUCTION

Inequities in child health are unjust, preventable and have a disproportionate impact on vulnerable populations (Braveman & Gruskin, 2003; Spencer, 2010). Children exposed to early childhood adversity such as poverty, abuse/neglect, unhealthy family functioning and parental mental health difficulties are at increased risk for poor physical and mental health in adulthood, low educational attainment and low income (Goldfeld & Hayes, 2012; Hughes et al., 2017; Shonkoff, 2012; Shonkoff & Phillips, 2000). At the societal level, inequities cause substantial social burdens such as reduced productivity and high social costs (Woolfenden et al., 2013). Based on data from the UK and USA, the estimated proportion of common childhood problems (e.g. low birth weight, psychological problems and disabilities) would be reduced by 30 to 70% if all children had the same health outcomes as their most socially advantaged peers (Granado-Villar et al., 2010; Spencer, 2008). This suggests that substantial health gains and economic savings can be achieved by redressing health and education inequities in the early years.

One popular approach to addressing early inequities involves implementation of home visiting programs (Duffee, Mendelsohn, Kuo, Legano, & Earls, 2017). Sustained Nurse Home Visiting (SNHV) programs, in particular, represent a promising strategy to improve a range of maternal and child health, wellbeing and education outcomes. Such programs specifically aim to promote health equity through a focus on disadvantaged/vulnerable families by delivering multiple services within the family's home environment in an intensive and sustained structure extended over months or years (Howard & Brooks-Gunn, 2009;

Landy & Menna, 2006). In this review, SNHV programs are defined as those delivered over a period of at least 12 months, predominantly by those with formal nursing or midwifery qualifications. For consistency with terminology in the existing literature, the acronym SNHV is used to cover both.

SNHV programs have the potential to overcome some of the complexities related to service access and dose (i.e. structural, familial and psychological barriers to attending centre-based services), as well as ensuring interventions are targeted to meet specific needs (Goldfeld, Price, & Kemp, 2018; Nievar, Van Egeren, & Pollard, 2010; Sweet & Appelbaum, 2004). Early experimental evaluations of SNHV programs demonstrated positive effects (Olds, 2008) and there has subsequently been significant financial investment in SNHV programs in the US (Miller, 2015; Olds et al., 2015), with a similar trend in other countries (Kemp, Cowley, & Byrne, 2017). Experimental evaluations of SNHV programs have also been conducted in Australia (Goldfeld et al., 2019; Kemp et al., 2011), the UK (Robling et al., 2016), Germany (Sierau et al., 2016) and the Netherlands (Mejdoubi et al., 2015).

1.1 Background

To date there has not been a systematic review of the evidence base supporting the increasing interest and investment in sustained NHV programs for disadvantaged families. Several meta-analytic reviews demonstrate the effectiveness of home visiting strategies broadly, showing positive effects across a range of outcomes related to child health and development, parenting and maternal self-sufficiency (Casillas, Fauchier, Derkash, & Garrido, 2016; Filene, Kaminski, Valle, & Cachat, 2013; Kendrick et al., 2000; Nievar et al., 2010; Sweet & Appelbaum, 2004). However, these reviews do not focus exclusively on nurse- or midwife-delivered programs and thus the SNHV contribution to the overall pooled effect is unclear. Though two reviews specifically investigate nurse-delivered home visiting programs, neither has focused on sustained programs for disadvantaged families. In one, most included programs were not sustained (i.e. limited to the prenatal or post-partum period) and the review did not include any programs trialed after the year 2000 (McNaughton, 2004) . The other review excluded programs targeting families with specific risks such as teen pregnancy or domestic violence and identified only three randomized controlled trials (Tanninen, Haggman-Laitila, Pietila, & Kangasniemi, 2016).

Findings across primary studies of SNHV programs are mixed. This is perhaps not surprising given objectives, content, intensity and duration, staffing and families targeted

vary between programs, despite being largely adaptations of NFP (Mejdoubi et al., 2015; Robling et al., 2016). The popularity and significant investment in SNHV programs despite the aforementioned limitations suggests that a more robust understanding of which programs work, for whom and for what outcomes is warranted. A systematic review of experimentally tested SNHV programs can more rigorously elucidate which child and parent outcomes are improved by specific SNHV programs.

2 THE REVIEW

2.1 Aims

The aim of this restricted review was to systematically evaluate published experimental studies of nurse or midwife delivered home-visiting programs, commencing during pregnancy or early in infancy and sustained for at least 12 months, to promote child and maternal health and wellbeing. The specific research question examined in this review is:

> Which SNHV programs for disadvantaged mothers have demonstrated evidence of a statistical effect on: child or maternal health, development, or well-being and/or maternal self-sufficiency (e.g. education, employment).

2.2 Design

The protocol for this study was established prior to its conduct and is registered at PROSPERO (CRD42018106781). Methodological decisions were guided by existing recommendations for best practice in completing restricted systematic reviews, also known as rapid reviews (Ganann, Ciliska, & Thomas, 2010; Kelly, Moher, & Clifford, 2016; Lockwood & Oh, 2017; Moher, Liberati, Tetzlaff, & Altman, 2009; Pluddermann, Aaronson, Onakpoya, Heneghan, & Mahtani, 2018) and review protocols for similar topics (Macdonald, Bennett, Higgins, & Dennis, 2010).

2.3 Search methods

Four electronic databases were searched: Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO and the Cochrane Central Register of Controlled Trials. Searches were limited to English language publications from January 2008 - 13 February 2018. Keywords and related terms were searched with the strategy taking the form: (social disadvantage) AND (mother) AND (home) AND (nurse) AND (study design). See Table 1 for the full list of search terms. Results were exported to Endnote X7.8. Additionally, reference lists of included studies were searched, content experts were consulted, and a

Mendeley library alert was maintained until the time of writing. A google scholar search was also conducted in September 2019 for each of the included SNHV programs.

The websites of several reputable evidence clearinghouses were also searched for relevant material using keywords 'nurse' or 'home visit'. These included: HOMVEE (https://homvee.acf.hhs.gov), Blueprints for Healthy Youth Development (www.blueprintsprograms.com), California Evidence-Based Clearinghouse for Child Welfare (www.cebc4cw.org) and Promising Practices Network on Children Families and Communities (www.promisingpractices.net).

2.4 Selection criteria

Studies of SNHV programs were included if they: (a) commenced during pregnancy or prior to the child's first birthday; (b) had an intended duration of at least 12 months; (c) were delivered predominantly by registered/qualified nurses or midwives (either solely or together with other professional/paraprofessional visitors) primarily in women's own homes; and (d) were tested with randomized- or cluster-randomized controlled trials (RCT/CRCT) designs. Restriction to programs tested in RCTs/CRCTs was to ensure only the highest levels of evidence were included, maximizing confidence that effects are attributable to programs rather than other factors.

Studies were excluded if the program: (a) did not specifically target mothers (e.g. foster parents, kinship carers, fathers); (b) recruited only clinical subgroups (e.g. mothers with post-natal depression); (c) targeted mothers of children with specific developmental disabilities or chronic illnesses; (d) aimed to address one specific outcome only (e.g. smoking, breastfeeding, obesity); (e) did not specifically target disadvantaged families; (f) took place in low- or middle-income countries; (g) was not compared with usual treatment; or (h) failed to meet our definition of SNHV. The review focus was restricted to relatively immediate effects; outcomes measured after child age five years were excluded. This decision was made when it became apparent that cross-program comparisons would not be possible for longer-term effects (as only one of the programs reported these).

Study design was limited to meta-analyses, systematic or program-specific reviews and RCT/CRCTs. Program-specific reviews provide a comprehensive summary of the evidence for a sole program but need not involve a systematic literature search. Meta-analyses and systematic reviews of home visiting programs, delivered by professionals to disadvantaged

families, were considered relevant but not included for data extraction unless results were reported separately for SNHV interventions.

2.5 Search outcomes

Search results were imported into EPPI-Reviewer 4 (Thomas, Brunton, & Graziosi, 2010). Titles and abstracts were screened and those retained were subsequently assessed for eligibility at full text. A random sample of 15% of the titles/abstracts and full texts were independently double-checked by a second reviewer. No discrepancies were identified at either stage of screening (i.e. 100% agreement).

Of 1393 unique references identified, 30 met inclusion criteria (see Figure 1). Most were identified via the academic database searches. Four papers were identified following search completion, either due to post-search publication/indexing, or Mendeley suggestions based on review library content. See Table S1 (online supplement) for a full list of excluded studies.

2.6 Quality appraisal

For each program evaluation, risk of bias (RoB) was assessed using an adapted version of the National Institute for Health and Care Excellence (NICE) quality appraisal checklist for quantitative intervention studies (NICE, 2012). This measure was selected as it is specifically designed for studies of public health interventions and is appropriate for a range of study designs including RCTs. Items address participant characteristics, allocation to intervention and control conditions, assessment of outcomes including blinding and methods of analysis. Each of 23 items was assigned a value of 0, 0.5, or 1.0 and summed so that higher total scores indicated higher quality. Study quality was then categorized high (≥75% criteria met), moderate (51-74%) or low (≤50%). As is recommended practice for systematic reviews, (Shea et al., 2017) details of trial funding and management of potential conflicts of interest were also checked. One paper for each program was randomly selected and double-coded by an independent reviewer. There was 100% agreement on overall rating categorizations. The AMSTAR 2 was used to assess the quality of reviews and meta-analyses (Shea et al., 2017).

2.7 Data abstraction

For each included study, the following information was recorded: citation information (e.g. author, year), study design (e.g. systematic review, RCT), study scope (e.g. pilot, efficacy, effectiveness), country of evaluation, intervention and comparison group descriptions, delivery processes (e.g. visit frequency and duration), program content, fidelity

of implementation, social validity (e.g. nurse or family perceptions of the program), intervention cost, sample characteristics (e.g. demographics, types of social disadvantage targeted), provider details (e.g. qualifications, experience, training), child outcomes (e.g. physical health, psychosocial development) and parent outcomes (e.g. physical health and health behaviors, parenting practices, psychosocial health and self-sufficiency indicators). Example indicators are provided in Table S2 (online supplement).

In cases where details of study methodology could not be coded without reference to earlier publications (e.g. pre-2008) or supplementary material, the additional publications were sourced. For each SNHV program, one publication was randomly selected for double-coding by an independent reviewer. No discrepancies emerged.

2.8 Synthesis

In cases where the extant literature has limited eligible trials or varied outcomes, it is appropriate to use a narrative rather than statistical approach to synthesizing findings (Lipsey & Wilson, 2001). Therefore, the approach used here involves verbal description of study findings and appraisal rather than quantitative meta-analysis of effect sizes. Results are organized according to intervention characteristics and outcomes.

3 RESULTS

3.1 Study and program characteristics

Included publications comprised 30 journal articles describing 7 different SNHV programs. These were: Nurse Family Partnership (NFP; 2 reviews of 3 RCTs), Family Nurse Partnership (FNP; 1 RCT), VoorZoorg (1 RCT), Pro Kind (1 pilot/interim RCT and 1 complete RCT), Minding the Baby (MtB, 1 CRCT with 2 phases), Maternal and Early Childhood Sustained Home visiting program (MECSH, 1 RCT) and MECSH-based right@home (1 RCT). For all programs, evaluation data were presented over multiple publications. Table 2 summarizes for each program the target population, models of delivery, program content and underpinning theory of change.

All programs except MtB, MECSH and right@home are NFP adaptations (Pro Kind purportedly lost NFP licensure as it was not consistently nurse delivered). All programs enrolled pregnant women antenatally and involved more intensive visiting schedules in the early post-partum period then tapered to child age two years. Total intended dose ranged from 19 to 91 visits. Program content and theoretical underpinnings were broadly similar. Content covered prenatal health, sensitive and competent caregiving and maternal self-

sufficiency factors. Theoretical underpinnings include human ecology (Bronfenbrenner, 1979), self-efficacy (Bandura, 1977) and human attachment (Bowlby, 1969).

Study quality was rated high for right@home, MECSH, VoorZorg and FNP (see online supplement, Table S3, for details of each evaluation). Evaluations of MtB and Pro Kind indicated moderate RoB (and the Pro Kind pilot trial was rated low quality). Information regarding NFP was drawn from two program-specific reviews (Olds 2008; Miller 2015); both were rated low quality using the AMSTAR 2. However, the original NFP papers (Kitzman et al., 1997; Olds, Henderson, Tatelbaum, & Chamberlain, 1986; Olds et al., 2002) were also assessed with study quality was rated moderate for two trials (Elmira, Denver) and high for a third (Memphis). Study funding was reported for all programs and all explicitly reported no potential conflicts of interest in at least one publication.

3.2 Reported outcomes

Many child and parent outcomes were reported within and across SNHV program evaluations. For interpretability child outcomes are categorized in two overarching domains: physical health (seven subcategories) and psychosocial/psychomotor outcomes (four subcategories). Parent outcomes fit four overarching domains: parenting practices (nine subcategories), physical health (four subcategories), psychosocial well-being (five subcategories) and maternal self-sufficiency (five subcategories). Within each subcategory, specific outcomes (e.g. breastfeeding) were measured in various ways, both across and also within studies (e.g. intentions, attempts, duration). See Tables 3 and 4 overviews of child and parent subcategory outcomes, respectively (detailed results are reported in online supplementary Tables S4 & S5). Table 5 lists the specific outcomes on which programs demonstrated evidence of a statistical main effect. For brevity, we refer to such effects as ‘statistically significant’.

3.3 Child outcomes

3.3.1 Physical health

Of three programs including child maltreatment measures, two demonstrated lower levels of maltreatment among intervention than comparison groups (NFP and VoorZoorg; not MtB though results were in the expected direction). Of three programs assessing child injuries, one demonstrated a positive effect (NFP, not Pro Kind or FNP). No program demonstrated a statistically significant main effect on: birth weight (assessed in all programs except right@home), preterm birth (assessed in FNP, MECSH, NFP and VoorZorg), common

childhood illnesses or general health (assessed in MECSH, Pro Kind, right@home), or infant mortality (assessed in NFP only). One program demonstrated a positive effect on child obesity (MtB). Few evaluations presented subgroup analyses. However, there is some evidence that the NFP improved birth weight and prevalence of preterm birth among subgroups with specific risk factors (i.e. very young mothers, smokers).

3.3.2 Psychosocial and psychomotor development

All seven programs evaluated at least one child psychosocial outcome. Of six programs, four demonstrated positive social-emotional effects (NFP, VoorZorg, Pro Kind, MtB; not MECSH or right@home). Measures of social-emotional development were standardized for two programs (Pro Kind, VoorZorg), while video footage was used for one (NFP) and biological data (cortisol) for another (right@home). Cognitive outcomes were assessed primarily with the Bayley Scales of Infant Development and one of three programs demonstrated positive main effects (Pro Kind), with subgroup effects emerging for the other two (NFP: mothers with low psychological resources; MECSH: distressed mothers). Of four programs including language or communication outcomes, three demonstrated positive main effects (NFP, FNP, right@home; not Pro Kind), two using parent-report measures. One program demonstrated an effect for psychomotor development, according to maternally reported concerns (FNP); the three programs not showing an effect used standardized assessments (MECSH, NFP and Pro Kind).

3.4 Parent outcomes

3.4.1 Parenting practices/approaches

All programs evaluated at least one parenting outcome and reported at least one statistically significant positive effect. These were reported for: breastfeeding in four of six programs (FNP, MECSH, NFP, VoorZorg; not Pro Kind nor right@home); smoking in two of six programs (NFP, VoorZorg; not FNP, MECSH, Pro Kind, right@home); child safety in two of three programs (MECSH and right@home; FNP $p < .10$); immunization compliance in one of five programs (MtB pilot; not FNP, MECSH, NFP Pro Kind); well child/routine check-ups in one of two programs (MtB pilot; not Pro Kind); parenting style in four of six programs (MECSH, NFP, right@home and VoorZorg; subgroup effect for low education mothers in MtB; no effect for FNP or Pro Kind); home learning environment in three of four programs (NFP, Pro Kind, right@home; subgroups for MECSH); and parenting-specific self-efficacy or maternal satisfaction in three of four programs (MECSH, Pro Kind, right@home; not FNP

though $p < .10$). Although most parenting measures require maternal self-report, positive effects were also demonstrated on measures incorporating independent observation (e.g. Home Observation Measurement of the Environment or use of biomarkers in the case of smoking).

3.4.2 Maternal physical health

Five programs evaluated at least one maternal physical health outcome (four reported at least one positive effect: MECSH, NFP, Pro Kind, right@home, not FNP). Statistically significant positive effects were reported for: antenatal health such as pregnancy-induced hypertension or gestational diabetes in two of four programs (MECSH, NFP; not FNP or Pro Kind); and post-natal health in two of four programs (MECSH;; right@home; not FNP or Pro Kind). There were no effects for vaginal delivery (though there was a trend for MECSH). Effects for health behaviors were observed in one program (Pro Kind, dental prophylaxis), but not another (FNP analyzed alcohol or illicit substance use). Note that positive effects for smoking behaviors are reported under parenting outcomes as the measurements often relate directly to child health (e.g. prenatal smoking, smoking near child).

3.4.3 Maternal psychosocial outcomes

All seven programs evaluated at least one maternal psychosocial outcome with four reporting at least one significant positive program effect. These were: family functioning in four of six programs (FNP, NFP, Pro Kind and VoorZorg, not MECSH); stress in one of four programs (Pro Kind, not FNP, MtB, right@home); and general self-efficacy or life satisfaction in one of three programs (FNP, not Pro Kind or right@home). Of three programs evaluating maternal anxiety and each using a different measure, only one demonstrated a statistically significant main effect (Pro Kind, not MtB, right@home). Finally, of the six programs including measures of depression, none reported a statistically significant main effect (though there were trends for MtB and Pro Kind).

3.4.4 Maternal self-sufficiency

Four programs assessed maternal self-sufficiency outcomes (FNP, NFP, Pro Kind, right@home). Statistically significant positive program effects were reported for: family

planning in two of four programs assessed using health records of subsequent births (NFP & MtB, not Pro Kind or FNP, though $p < .10$ for FNP contraceptive use), employment in one of three programs (NFP, not FNP or right@home) and welfare use in one of two programs (NFP, not FNP). A possible difference was observed for homelessness in the one program to assess it (FNP, $p < .10$). None of the four programs measuring educational attainment reported a positive effect (FNP, NFP, Pro Kind, right@home).

3.5 Program effects for specific subgroups

Several positive program effects were accentuated for, or specific to, subgroups. For children born to women who smoke or smoke excessively during pregnancy, the NFP demonstrated positive effects on irritability and preterm birth. For children born to low income, unmarried teenage mothers (Elmira trial) or women with low psychological resources (Memphis trial), the NFP demonstrated positive effects on maltreatment. For children born to women considered especially at-risk, three programs report positive effects on cognitive development (Pro Kind, NFP and MECSH) and one reported positive effects for language (NFP: white, low income teens in Elmira and low-resource mothers in Denver).

For parenting style there were positive effects for mothers who: were young (MtB); primiparous (MECSH); had multiple risk factors (MECSH, right@home); low resources (NFP Memphis, Denver), or poor mental health (right@home). There is also some evidence of positive program effects on maternal satisfaction for primiparous, immigrant and distressed mothers (MECSH) and on depression and prescription of calmative psycholeptics for mothers at 'increased-risk' (Pro Kind). For family planning and employment there were positive effects for low-income, unmarried mothers (NFP Elmira).

4 DISCUSSION

This restricted systematic review compared the effectiveness of seven SNHV programs on child and maternal outcomes spanning physical and psychosocial health, parenting practices and maternal self-sufficiency. Although difficult to make comparisons for specific outcomes (due to variability in what was evaluated and how), each program demonstrated at least one positive outcome (Table 5), with the NFP demonstrating positive effects across the widest range of outcomes. Several programs assessed in high quality trials (e.g. VoorZorg, MECSH and right@home) also had positive effects on critically important outcomes (e.g. child maltreatment, breastfeeding duration, smoking, parenting skills/interaction and domestic

violence). The results show SNHV programs are most consistently effective for parenting outcomes and some programs are particularly effective for specific 'higher risk' subgroups (i.e. mothers who in addition to specific indicators of disadvantage: are young, have low psychological resources, or experience multiple forms of adversity).

The NFP demonstrated positive effects on child physical and psychosocial health outcomes, as well as maternal physical and psychosocial health, parenting skills and self-sufficiency outcomes. Possible explanations for the wider range of NFP effects compared with other programs include: (a) multiple trials across different populations (i.e. Elmira, Memphis, Denver) and (b) the health care context where NFP was trialed. As others have noted (Olds, 2016; Robling et al., 2016; Sandner, Cornelissen, Jungmann, & Herrmann, 2018) the usual services available to comparison groups in contemporary SNHV trials are more comprehensive than those afforded by the United States health care system of the 1990s and earlier.

Among the contemporary SNHV programs tested in high quality trials, VoorZorg demonstrated effectiveness across the most outcomes, including child internalizing behaviors, maltreatment, maternal smoking, breastfeeding duration, intimate partner violence and parenting skills. MECSH and right@home similarly demonstrated positive and consistent effects across several parenting outcomes (e.g. child safety, parenting style and parenting-efficacy) and additionally demonstrated positive effects for maternal physical health. In the case of right@home and FNP positive effects were also observed on some child development measures (language, communication).

When evaluating the strength of evidence for specific outcomes it is important to acknowledge that for some programs, effects have sometimes been measured by parent-report only. Where positive effects have emerged on both parent-report and objective measures of the same outcome (e.g. smoking), the evidence that SNHV programs are effective for those outcomes is stronger. For some outcomes results on parent-report and biological measures diverge. In the case of child social-emotional development, for example, there are positive effects on parent report measures (e.g. child internalizing in VoorZorg) but not biological measures (e.g. stress in right@home). This does not mean SNHV programs are ineffective for social-emotional development. Rather, it highlights the need for future research to include a range of measures for specific outcomes across trials.

Along a similar line, it may prove useful for researchers to disentangle parent-report and observational items used in measures such as the HOME inventory and report separately which have significant effects. We were unable to investigate such differences as SNHV researchers using the HOME have not reported such detail. Where different approaches to measurement yield different results, it is also important to consider the challenges associated with each measurement type (e.g. social desirability in self-report, demand effects when behavior is recorded/observed – even when coders are blinded, surveillance effects when nurses must contribute to child protection investigations, limited statistical power when biological or administrative data is not available for the full study sample, effects of nurses encouraging help-seeking behaviors on accident/injury data). Though more objective data is desirable, it should also be interpreted cautiously.

SNHV programs appear especially beneficial for mothers with specific high-risk indicators or those experiencing multiple risks. Indeed, several programs demonstrated more pronounced effects on some measures for first-time/young mothers (MECSH, NFP, MtB) and those with multiple risk factors (MECSH, Pro Kind, right@home), or low psychological resources (MECSH, NFP). However, this does not imply that SNHV programs should target these groups to the exclusion of others. Subgroup analyses in SNHV trials are generally underpowered and positive main effects demonstrated in trials such as right@home suggest that most women meeting 'disadvantaged' selection criteria benefit. Additionally, operationalization of subgroups varies (e.g. the cut-point for young mothers was 20 years for MtB, but 17 for NFP). As the extant program evaluations have not reported comparable sub-group analyses (e.g. some consider demographic groups, others look at psychological resources), it is difficult to assess subgroup replication across SNHV studies. Clearly, there is a need for future research to test whether the findings reported for specific subgroups replicate across different programs and service system contexts.

Similarly, there is a need to assess the economic benefit of SNHV programs in varied service systems. To date, it appears only one of the contemporary SNHV programs reviewed here has undergone such an evaluation (Corbacho et al., 2017). Though results indicated that immediate effects of the FNP program in the UK were not cost-effective relative to existing universal services, potential longitudinal effects are yet to be assessed. Moreover, there are indications that other SNHV programs may provide greater value for money (Goldfeld et al., 2019; Stamuli, Richardson, Duffy, Robling, & Hood, 2015).

Overall, the findings support the use of SNHV programs to improve parenting practices among disadvantaged mothers and particularly specific subgroups. The results also suggest SNHV programs generally have positive effects for several child psychosocial outcomes. These are presumably mediated by improved parenting style (e.g. warm, responsive, less hostile interactions) and the home learning environment. In theory, such effects should increase the likelihood of positive long-term impacts (e.g. preventing later difficulties with academic achievement and mental health problems and improving economic self-sufficiency). In contrast, the results raise questions about the immediate effectiveness of contemporary SNHV programs for addressing some child physical health outcomes such as birthweight, preterm birth and maternal mental health. However, a recent large scale propensity matching study of NFP found a significant reduction in preterm births suggesting statistical power limitations could mask the effect on some outcomes in RCTs (Thorland & Currie, 2017). Limited effectiveness for some outcomes is perhaps indicative of the need for broad structural changes that address issues with equity and access that direct service provision alone cannot accomplish. As others have noted, the current approach to addressing disadvantage by emphasizing parent education and support may need buttressing by strategies that address neighborhood and workplace factors beyond parent control (Bullock, 2019; Shonkoff & Phillips, 2000).

The pattern of largely mixed results suggests a need to more closely examine the specific program componentry, or 'active ingredients', associated with SNHV programs that do demonstrate positive effects on specific outcomes. Though previous research has investigated the relationship between home visiting componentry and program effectiveness (Filene et al., 2013), sustained nurse-delivered programs have not received specific evaluation.

4.1 Limitations

Multiple searches across scientific databases, trial registries and evidence clearinghouses; verification of selection decisions by a second reviewer; and detailed study quality appraisals are significant strengths of this review. However as is common practice for restricted systematic reviews, concessions were made to review breadth and depth (Pluddermann et al., 2018). Specifically, the database search was limited to journal articles published from 2008 to early 2018. This presents some risk that not all SNHV programs evaluated in RCTs or CRCTs will have been identified, though it is mitigated by the Google search and Mendeley alert system. The approach also affords several strengths including an emphasis on the most

recently and rigorously trialed programs (increasing the applicability of findings to contemporary health care systems and ensuring that the implications are premised on high quality studies). While inclusion of program-specific reviews and meta-analyses ensured that the most researched and influential SNHV program (NFP) was not missed altogether, it is possible some effects of the NFP have been missed. However, three seminal NFP publications (Kitzman et al., 1997; Olds et al., 1986; Olds et al., 2004) were checked for such cases.

It is important to acknowledge that the analytic strategy considered whether programs had any relevant effect for a given outcome in the first five years following childbirth. When statistically significant effects were observed they were recorded. To some extent, this may obscure cases where programs have demonstrated mixed results (for example, across different measurements of a similar construct, different time points and different trials [NFP] or phases [MtB, Pro Kind] of the same program) and could reflect some publication bias. There is also a possibility that some effects reflect Type I errors, while the lack of effects may in some cases be attributable to Type II errors. Summary tables should therefore be interpreted cautiously and the more detailed tables (see online supplements) including estimates of effect size and precision should be consulted where implementation of a given program is being considered. It is worth noting here, however, that many of the observed effects indicate differences that would be meaningful to both mothers and policy-makers.

This review focused on outcomes reported from pregnancy to child age five years. Though knowing the longer-term effects of SNHV programs will be important for guiding policy and practice, the extant literature is fairly limited. Only one of the programs (NFP) has reported longer term effects. It is worth noting that although results have been mixed, some NFP follow-ups indicate positive long-term effects for both child and parent outcomes. For children, examples include maltreatment from 4-15 years, arrests from 11-19 years and drug use and internalizing problems at 12 years (Kitzman et al., 2010; Miller, 2015). For parents, examples include self-reported maternal welfare use over 15 years and maternal role impairment due to drug or alcohol use at 12 years (Miller, 2015; Olds et al., 2010). Whether similar effects emerge for the other SNHV programs is not yet clear. When longer term follow-ups are published, future reviews should include these results for cross-program comparison.

Further research is also needed to identify the specific program componentry (such as process of delivery, provider characteristics and curriculum content) associated with

successful SNHV programs. We plan to use the findings from this review to inform such an investigation. There is also a need to explore the magnitude of SNHV program effects. For most outcomes included in this review the scarcity of RCT-level studies including specific outcomes and wide variation in measurement approaches impeded meaningful meta-analysis. However, future research encompassing more study designs could investigate both the overall magnitude of SNHV programs on specific outcomes and explore moderating effects of program componentry.

5 CONCLUSIONS

In addition to the seminal US-based NFP trials of the late 1970s to early 1990s there have been recent and rigorous evaluations of SNHV programs across a variety of other health care systems (e.g. Australia, Germany, the United Kingdom and the Netherlands). The extant literature supports the benefits of nurse home visiting programs that are sustained, though the relative impact on different domains and for different subgroups varies greatly. Nevertheless, for some outcomes (e.g. parenting approaches), positive effects are largely replicated across different groups and different health and human-service systems. This review serves as a useful resource for practitioners, policy-makers and researchers interested in identifying which SNHV programs work, for whom and on what outcomes.

Conflict of interest statement:

Professor Sharon Goldfeld was instrumental in the design, implementation and prior evaluations of one of the programs included in this review. To manage this potential conflict of interest, she was not involved in: initial review protocol development, screening of papers for inclusion, data extraction, or assessment of study quality. The remaining authors have no conflicts of interest or financial relationships relevant to this article to disclose.

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TABLE 1. Database search terms

Concept	Keywords
Social disadvantage	Vulnerable or at-risk or disadvantage or underprivilege or poor or poverty or impover* or deprived or low SES or low socio-economic-status or low-income or single-parent or sole-parent or youth or young or teen* or adolescen* or welfare payment or welfare benefit
Mother and infant	mother or maternal or infant or infancy or newborn or child* or minor or toddler or baby or babies
Nurse	Nurs* or midwife or midwives
Home	home or house or home-based or home-visit or home-care
Study design	RCT or randomi* or control* or trial or clinical or random* assign* or random* alloca* or QRCT or quasi* or quasi-ex* or quasiex or meta-analysis or systematic review

TABLE 2. Characteristics of included SNHV programs

Program	Population	Timing of enrolment and child age at completion	Intended frequency of visits and mean number delivered	Visitor qualifications	Program content	Theory of change
Family Nurse Partnership (NFP adapted under license) (Corbacho et al., 2017; Robling et al., 2016)	United Kingdom, 2009-2014 IG: *n* = 782 CG: *n* = 786 Targeted: Teenage (≤ 19 years) first-time mothers English-speaking	Antenatal (< 25 weeks gestation) – 2 years	Intended visits: up to 64, frequency not explicitly specified but likely as per NFP Visits delivered: *M* = 39 (*SD* = 15)	Nurse (*n* = 131, majority with undergraduate degree)	• Prenatal health • Sensitive and competent caregiving, • Maternal self-sufficiency	Human ecology, self-efficacy, and human attachment
Maternal & Early Childhood Sustained Home visiting	Australia, 2005-2008 IG: *n* = 111 CG: *n* = 97	Antenatal (avg 26 weeks; range 12-40 weeks) – 2 years	Intended frequency: antenatal = fortnightly; Birth to 6 weeks = weekly; 1.5 to 3 months = fortnightly; 3-6	Nurse (*n* = 5; all Bachelor level or equivalent, most with post-graduate child and family	• Child development and caregiving • Family biopsychosocial health	Human ecology, self-efficacy, and human attachment [b]

(Kemp et al., 2006; Kemp & Harris, 2012; Kemp et al., 2008; Kemp et al., 2013; Kemp et al., 2011)	Targeted: ≥ 1 risk factor[a] , either multi- or primiparous English-speaking		months = monthly; 6 months-2 years = bi-monthly Visits delivered: antenatal *M* = 2.9, and total *M* = 16.3 (range 0-53)	qualification + program specific training)	• Referral and support	
Minding the Baby (CRCT)(Ordway et al., 2014; Ordway et al., 2018; Sadler et al., 2013; Slade et al., 2019; Slade et al., 2005)	USA, 2002-2016 Phase 1 (2002-2008): IG *n* = 60, CG *n* = 45 Phase 2 (2008-2016): IG *n* = 60, CG = 64 Targeted: primiparous, 14-25 years, no psychotic	Antenatal (3rd trimester)- 2 years	Total 91 planned visits Intended frequency: 3rd trimester to child age 1 year: weekly; 1-2 years: fortnightly; Visits delivered: 3.5 per month (*SD* = 1.5), Phase I & II: *M* = 72 *SD* = 39	Nurse (*n* = 2) and social worker (*n* = 5) alternate (both with masters-level qualifications)	• Child development and caregiving • Family biopsychosocial health • Reflective functioning	Infant-parent psychotherapy; human ecology, self-efficacy, human attachment

	disorder or drug misuse) English-speaking					
Nurse-Family Partnership (Kitzman et al., 1997; Miller, 2015; Olds, 2008; Olds, Henderson, Tatelbaum, & Chamberlain, 1986; Olds et al., 2002; Sidora-Arcoleo et al., 2010)	USA 1978-1980: Elmira (*n* = 400; IG =116 vs CG = 184; remainder pre-natal visits) 1990-1991: Memphis (*n* = 1138; IG = 228 vs CG = 515; remainder no post-partum care or limited care) 1994-1995: Denver (*n* = 735; 235 nurse-visited vs	Antenatal (< 29 weeks gestation for Elmira & Memphis; pre-delivery for Denver) – 2 years	Up to 62 visits Intended frequency: Antenatal: fortnightly; Birth-1 month: weekly; 1-18 months: diminishes from fortnightly; 18-24 months: 6-weekly Visits delivered: Elmira = 9 prenatal, 23 post; Memphis: 7 prenatal, 26 post; Denver: 6.5 pre, 21 post.	Nurse (Bachelor qualification with 'experience' in community or maternal-child field)	• Prenatal health • Sensitive and competent caregiving, • Maternal self-sufficiency	Human ecology, self-efficacy, and human attachment

	255; remainder paraprofessional) Targeted: Elmira: young (< 19 yrs), single, low SES; Memphis: unmarried, unemployed, low education; Denver: primiparous & no insurance/ Medicaid-qualified					
Pro Kind (Brand & Jungmann, 2012, 2014; Jungmann et al., 2015; Jungmann, Ziert, Kurtz, & Brand, 2009; Sandner, Cornelissen,	Germany, 2006-20012 Pilot: IG: *n* = 38 CG: *n* = 38 Trial: IG: *n* = 394 CG: *n* = 361	Antenatal (12-28 weeks pregnant) – 2 years	Intended frequency: antenatal: weekly; Birth-4 weeks: weekly; 1-18 months: fortnightly; 18-24 months: monthly Visits delivered (in trial, not pilot): *M* =	Midwives (*n* = 36, +1 nurse) and social workers (university/college qualified midwife for 60% of sample; 40% had midwife up to 6 weeks postpartum then social worker for remainder, with	• Prenatal health • Sensitive and competent caregiving, • Maternal self-sufficiency	Human ecology, self-efficacy, and human attachment

Jungmann, & Herrmann, 2018; Sandner & Jungmann, 2017; Sierau et al., 2016)	Targeted: primiparous mothers at economic risk [c] with ≥1 social risk factor [d]; 25% self-referred German-speaking		32.7 (*SD* = 18.6) range 0-94	three combined visits in pregnancy)		
right@home (Goldfeld & Hayes, 2012; Goldfeld et al., 2017; Goldfeld, Price, & Kemp, 2018; Goldfeld et al., 2019)	Australia, 2013-2014 IG: *n* = 363 CG: *n* = 359 (≥ 2 of 10 risk factors) [e]	Antenatal (<37 weeks) – 2 years	Intended visits: 19-31 Intended frequency: Antenatal: 3 visits Birth-6 weeks: weekly 6-12 weeks: fortnightly 12-26 weeks: 3-weekly 6-12 months: 6-weekly 1-2 years: bi-monthly Visits delivered: *M* = 22.7 (*SD* = 7.4)	Nurse (*n* = 18, all with postgraduate qualifications + Family Partnership Model training) ~25 nurse visits + ≥ 1 social worker visit.	• Child development and caregiving • Family biopsychosocial health • Referral and support	Human ecology, self-efficacy, and human attachment

VoorZorg (NFP with cultural adapations) (Mejdoubi et al., 2014; Mejdoubi et al., 2015; Mejdoubi et al., 2013; Mejdoubi et al., 2011)	Netherlands, 2007-2009 IG: *n* = 237 CG: *n* = 223 Targeted: low income, ≤25 years, primiparous, + ≥1 other risk factor [f] Dutch-speaking	Antenatal (≤ 28 weeks)– 2 years	Intended visits: antenatal: 10 visits; Birth-1year: 20 visits; 1-2 years: 20 visits Dose delivered: antenatal *M* = 9 visits (*SD* = 4). Postnatal not reported	Nurse (*n*= 25 'certified' nurses, level of qualification not reported, 2 years relevant experience)	• Prenatal health • Sensitive and competent caregiving, • Maternal self-sufficiency	Human ecology, self-efficacy, and human attachment

[a] Risk factors were: <19 years age, distress (Edinburgh Depression Scale), low support, late to seek antenatal care, major stressors, substance misuse, childhood abuse, IPV, mental health problems. Of the first-time mothers, only 25 of 65 were teenagers; [b] Kemp et al (2013) indicate that the MECSH program uses 'an ecological approach', to 'promoting self-efficacy', and has 'an attachment focus'; [c] Unemployment or over-indebtedness; [d] Low education, experience violence, neglect, social isolation, teenage pregnancy, health problems ; [e] risk factors related to education, income, employment, living alone, global health, chronic illness, smoking, youth, anxiety, low support; [f] risk factors related to: single relationship status, domestic violence, psychosocial symptoms, unwanted pregnancy, financial stress, housing difficulty, no employment, low education, alcohol or drug use; IG: intervention group; CG: control group; *n*: sample size; *M*: mean; *SD*: standard deviation

TABLE 3. Overview of program effects on child outcomes

Program	Study Quality	Child Physical Health							Child Psychosocial & Psychomotor Development			
		BW	PT	IL/DE	OB	AC	MA	MO	PMD	COG	LAN	SED
FNP (UK)	++	ns§	ns§			ns§	N[a]		Y		Y	
MECSH (AUS)	++	ns§	ns§	ns§					ns‡	ns†‡		ns
MtB (USA)	+	ns§			Y§		ns*					Y‡
NFP (USA)	+[b]	ns*†§	ns†§			Y†§	ns†	ns§	ns‡	ns†	Y†‡	Y†
Pro Kind (GER)	-/+[c]	ns§		Y§		ns§			ns‡	Y†‡	ns‡	Y[d]
right@home (AUS)	++			ns§							Y[e]	ns§
VoorZorg (NL)	++	ns§	ns§				Y					Y

*indicates p<.10; †subgroup effect was statistically significant; ‡= standardized observational test (not parent-report); § indicates biological or medical administrative measures used; ns = no statistically significant main effect; Y = statistically significant (p<.05) main effect of program on at least one relevant measure; - indicates low study quality; + indicates moderate quality; ++ indicates high quality; [a] A significant effect indicated higher rates of safeguarding procedures among the intervention group, however authors suggest this reflects surveillance bias rather than a negative program effect; [b] both NFP reviews were rated low in study quality, however, assessment of the original papers indicates moderate risk of bias for the Elmira and Denver trials, with low risk for Memphis; [c] Jungman (2009) pilot study rated low in quality, but all other Pro Kind papers rated moderate; [d] Positive program effect on infant temperament reported in low quality pilot trial only; [e] Positive effects for communication were significant across multiple items in unadjusted analyses, and on a single item in adjusted analyses; AC = Accidents, Injuries, Ingestions; BW=Birthweight; COG=Cognitive; IL/DE=Illnesses or general health or dental health; LAN=Language & Communication; MA=Maltreatment (safeguarding, child protection services reports); MO=Mortality; OB= Obesity; PMD=psychomotor development; PT=Preterm/gestation; SED=Social-emotional development

TABLE 4. Overview of program effects on parent outcomes

Program	Study Quality	Parenting									Maternal Physical Health				Maternal Psychosocial Health					Maternal Self-Sufficiency				
		BF	FC	SM	CS	IC	CU	PS	HL	PSE	AN	DEL	PN	HB	DEP	ANX	STR	FF	GSE	FP	ED	EM	WE	HO
FNP	++	Y	ns	ns[§]	ns*	ns		ns[¶]		ns*	ns		ns	ns	ns		ns	Y	Y	ns*[§]	ns	ns	ns	ns*
MECSH	++	Y		ns	Y[¶]	ns		Y[‡∧¶]	ns[*‡†]	Y[†]	Y*[§]	ns*[§]	Y		ns			ns						
MtB	+					Y[§]	Y[§]	ns[a†‡]							ns*	ns	ns	ns[†]		Y[§]				
NFP	+[b]	Y[§]		Y[§]		ns[§]		Y[†‡]	Y		Y[§]				ns			Y		Y[†]	ns	Y	Y[¶]	
Pro Kind	-/+[c]	ns	ns	ns		ns	ns	ns[‡]	Y[†]	Y	ns	ns	ns[§]	Y[§]	ns*[§]	Y[†§]	Y	Y	ns	ns[d§]	ns			
right@home	++	ns	N[e]	ns	Y			Y[†‡]	Y[†]	Y			Y		ns	ns	ns[§]		ns		ns	ns		
VoorZorg	++	Y		Y				Y[‡]										Y						

*indicates p≤.10; [†]subgroup effect was significant; [‡]= observational data included in measurement (not parent-report only); [§] indicates biological or administrative data used in measurement (sometimes in combination with self-report, such as cotinine and self-report used for smoking in FNP or health record and self-report for childbearing in MtB);[¶] effect not significant on observational-only or administrative data measures; nr = assessed but not reported; ns = no statistically significant main effect; Y = statistically significant (p<.05) main effect favoring program on at least one measure; N= statistically significant effect favoring usual treatment group; - indicates low study quality; + indicates moderate quality; ++ indicates high quality; [a] Though there was a positive effect on maternal reflective functioning, this was not considered a direct measure of parenting style; [b] both NFP reviews were rated low in study quality, however, assessment of the original papers indicates moderate risk of bias for the Elmira and Denver trials, with low risk for Memphis; [c] Jungmann (2009) pilot study rated low in quality, but all other Pro Kind papers rated moderate; [d] Jungmann (2015) reported significantly higher rates of subsequent pregnancies among intervention mothers at child age 3 years but Sandner et al (2018) reported no significant differences using administrative data (hospitalization, and contraceptive prescriptions); [e] Child ate breakfast item favored control participants. **Parenting outcomes:** BF=Breastfeeding; CS=Child Safety; CU=Well-child check-ups; FC=Food choices; HL=Home learning environment; IC=Immunization compliance; PS=Parenting style (e.g. warm, responsive, hostile approach);PSE=Parenting-specific efficacy, maternal satisfaction, and attachment; SM=Smoking; **Physical health:** An=Antenatal (e.g. pregnancy-induced hypertension, gestational diabetes); DEL=Delivery (e.g. assisted vaginal, caesarean); HB=Health behaviors (e.g. alcohol & drug-use FNP, dental checks in Pro Kind); PN=Post-natal health including general health and therapeutic dental consultations or

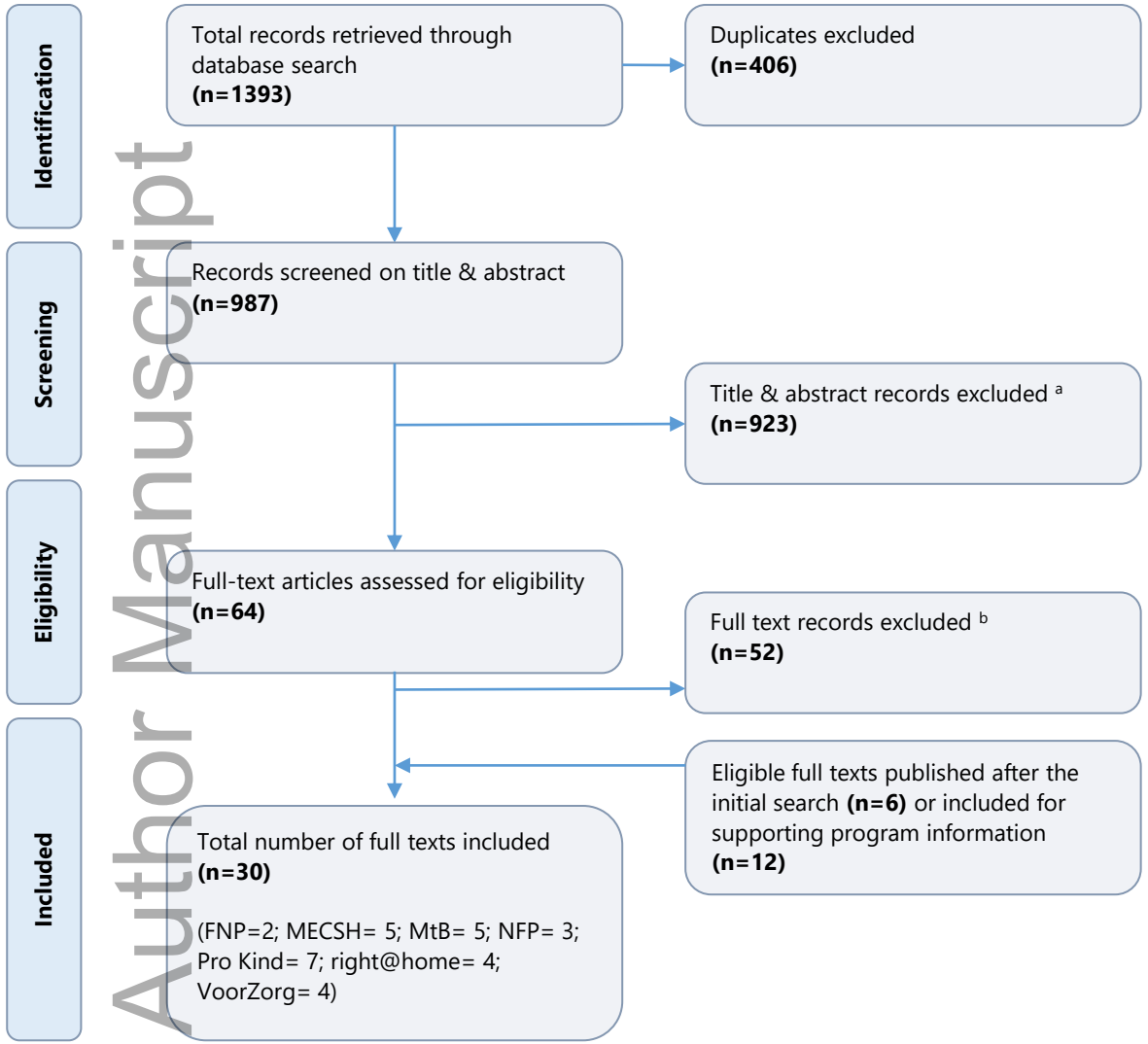
disease, **Psychosocial health:** ANX=Anxiety; DEP=Depression; FF=Family functioning (including intimate partner violence; partner satisfaction, living arrangements); GSE=General self-efficacy or life satisfaction (not parenting specific); STR=Stress; **Maternal self-sufficiency:** ED=Education; EM=Employment; FP=Family planning (e.g. subsequent pregnancies, contraceptive use); HO=Housing; WE=Welfare

TABLE 5. Statistically significant main effects of SNHV programs on child and parent outcomes

Program	Positive Child Effects (age)	Positive Parent Effects
FNP	• Language (12, 18, 24 months) [1] • Psychomotor development (24 months) [1]	• Breastfeeding intentions (prenatal) [1] • Social support [1] • Partner satisfaction [1]
MECSH		• Post-partum health [2] • Breastfeeding duration [3] • Parent responsivity [3] • SIDS knowledge [2] • Parent self-efficacy [2]
MtB	• Infant attachment (12 months) [4] • Obesity (24 months) [6] • Externalizing (36-60 months) [7]	• Immunization compliance [4] • Maternal reflective functioning [5] • Family planning (subsequent births)[4]
NFP	• Injuries & ingestions (24 months) [8,9] • Language (24, 48 months) [9] • Emotional vulnerability (6 months) [8] • Aggression (24 months) [10]	• Prenatal physical health [8,9] • Smoking (prenatal) [8,9] • Breastfeeding initiation [8,9] • Parent responsivity [8] • Child rearing beliefs [8] • Home learning environment [8] • Family structure and IPV [8,9] • Family planning (subsequent births) [8,9] • Welfare use and employment [8]
Pro Kind	• Dental health (24 months) [11] • Cognitive (12 months, not 24) [13] • Temperament (6 months) [13]	• Dental health [11] • Maternal attachment [12] • Parent self-efficacy [12] • Home learning environment [14] • Maternal stress [11,12] • Partner satisfaction [12]

right@home	• Language/Communication (24 months) [15]	• Post-partum health [15] • Parent self-efficacy [15] • Parent responsivity [16] • Home learning environment [16] • Home safety [16]
VoorZorg	• Maltreatment (36 months) [17] • Internalizing (24 months) [17]	• Home learning environment [17] • Smoking (pre- & post-natal) [18] • Intimate partner violence [19] • Breastfeeding duration [18]

[1] Robling et al (2016); [2] Kemp et al (2013); [3] Kemp et al (2011); [4] Sadler et al (2013); [5] Slade et al (2019); [6] Ordway et al (2018); [7] Ordway et al (2014); [8] Olds (2008); [9] Miller et al (2015); [10] Sidora-Arcoleo et al (2010); [11] Sandner et al (2018); [12] Sierau et al (2016); [13] Jungmann et al (2009); [14] Sandner et al (2017); [15] Goldfeld et al (2019); [16] Goldfeld et al (2018); [17] Mejdoubi et al (2015); [18] Mejdoubi et al (2014); [19] Mejdoubi et al (2013)



[a] Papers were excluded on type of country (n=87), intervention (n=191), outcomes (n=41), publication (n=114), study design (n=273), and target group (n=217).

FIGURE 1. Flow chart of literature search and selection process results.