Journal of Affective Disorders 241 (2018) 154–163

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research paper

Screening fathers for postpartum depression can be cost-effective: An example from Sweden

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ABSTRACT

Background: : Postpartum depression negatively affects the whole family and its prevalence in Sweden ranges between 6–10% for fathers and 13–16% for mothers. However, only mothers in Sweden are currently routinely screened.
Aim: : The aim of this study was to determine if a postpartum depression screening for fathers in Stockholm County could be cost-effective.
Methods: : National Swedish databases were used to find registry data and a literature review was undertaken to identify the model data inputs associated with postpartum depression in Sweden. The generated evidence was used to build a Markov model in TreeAge. One-way and probabilistic sensitivity analyses were performed to account for parameter uncertainties. Alternative scenario analyses were further undertaken to test the assumptions in the base case analysis.
Results: : A postpartum screening for depression in fathers is cost-effective in base case and alternative scenarios. The results indicate that the screening program is associated with lower costs and higher health effects. The results were sensitive to variables of quality adjusted life years for the depressed fathers, probabilities of remission in treatment and no treatment groups and start age and productivity losses. The probabilistic sensitivity analysis resulted in a 70% probability of the postnatal depression screening intervention being cost-effective.
Limitations: : The current study only uses secondary data; therefore future research should assess the cost-effectiveness of screening fathers for depression.
Conclusion: : The postpartum screening intervention for fathers could be cost-effective compared to no screening. Future research should replicate the potential cost-effectiveness for screening fathers for postpartum depression.

1. Introduction

Fathers are at an increased risk of depression during the postpartum period, where international reviews show that around 10% of fathers have symptoms of post-partum depression (PPD) three to six months after delivery (Paulson & Bazemore, 2010). In Sweden, the national prevalence is between 6–13% for fathers (Bergström, 2013; Centre for Epidemiology and Community Medicine 2015; Massoudi et al., 2016). Despite this, mothers, but not fathers, in Sweden are routinely screened for PPD at the child health centers (CHCs) (The National Board of Health and Welfare 2016; Vårdgivarguiden 2016). Since PPD is associated with an increased risk of suicide (Quevedo et al., 2011), as well as having an increased risk of parental separation (Goodman, 2004; Seto et al., 2005) and adverse consequences for children´s development (Halligan et al., 2007; Kane & Garber, 2004; Ramchandani et al., 2008; Ramchandani et al., 2005), a further exploration is warranted regarding whether or not new fathers should be routinely screened for PPD.

1.1. PPD and fathers

PPD is a form of depression that usually occurs between the fourth week and 12th month post-delivery (Serhan et al., 2013; Seyfried & Marcus, 2003; Vigod, 2016). Risk factors for fathers developing PPD is if their partner has PPD and if they have been previously depressed (Goodman, 2004), as well as having a low education level, being financially disadvantaged (Ramchandani et al., 2008), and currently going through a traumatic life experience such as divorce, serious sickness or loss of a close family member (Massoudi et al., 2016; Ramchandani et al., 2008). Treating fathers for PPD may be societally beneficial, as fathers with PPD have higher healthcare costs than non-depressed fathers (Edoka et al., 2011).

1.2. Swedish child health centers and screening

Being one of the most gender equal countries in the world

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https://doi.org/10.1016/j.jad.2018.07.044
Received 9 January 2018; Received in revised form 1 June 2018; Accepted 14 July 2018
Available online 24 July 2018

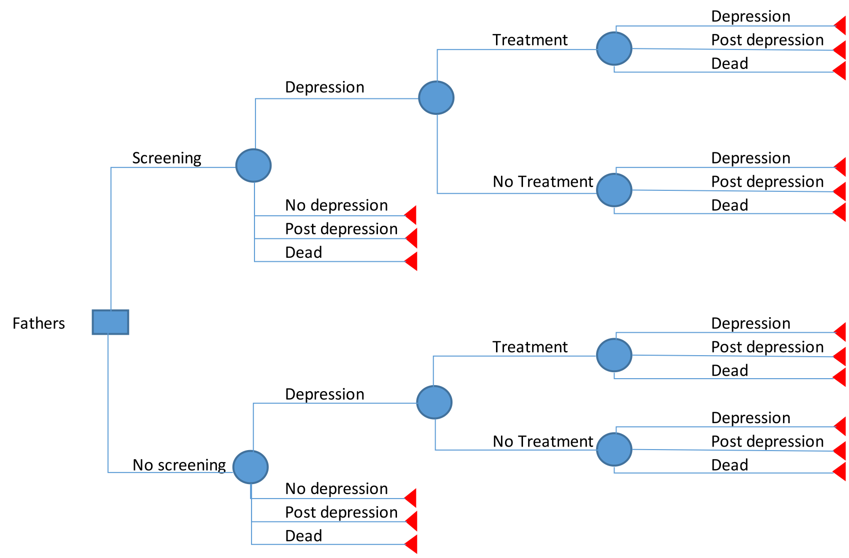

Fig. 1. A TreeAge model demonstrating the pathway in the model for fathers in the screening and no screening groups.

(World Economic Forum 2016), Sweden sought to involve fathers through its family policies (Wells & Bergnehr, 2014) and its child health program (Wells, 2016). The Swedish government has further implemented a national parental support strategy by offering both parents free community services, as well as parenting advice and support from early pregnancy until the child turns 18 (Swedish Agency for Health Technology Assessment and Assessment of Social Services 2008).

As a part of this support, around 97–99% of families visit the CHCs, where they provide free child healthcare, immunizations, and answer parenting questions, as well as provide parents with parent education groups during the infants' first year (Wells & Sarkadi, 2012). CHC nurses also routinely screen mothers, but not fathers, for PPD (Stockholm county council 2015), using the Edinburgh Postnatal Depression Scale (EPDS) (The National Board of Health and Welfare 2016), which has been validated in 34 studies (Gibson et al., 2009), including in Sweden, for both mothers (Cox et al., 1987; Wickberg & Hwang, 1997) and fathers (Massoudi et al., 2013; Matthey et al., 2001).

1.3. Depression costs and effects

Depression is the third largest cause of disability in Sweden (Institute for Health Metrics and Evaluation 2017), and has negative consequences on the economic performance of the individual (Sobocki et al., 2007a; The National Board of Health and Welfare 2013), leading to job absenteeism and premature retirement (Sobocki et al., 2007b). Other major expenses include costs for medications, healthcare visits and hospitalizations (Sobocki et al., 2007a). In fact, antidepressant medications in Sweden have the second highest prevalence, with a total spending of € 699,827,02 in 2015 (The National Board of Health and Welfare 2015a).

The topic of screening fathers for PPD is particularly important since it has significant public health relevance and implications (Centre for Epidemiology and Community Medicine 2015). Besides a wider family focus, screening could be seen as a health promotion activity leading to improvements in father's health, general family functioning and children's psychological and social functioning (Centre for Epidemiology and Community Medicine 2015; Ramchandani et al., 2008; Serhan et al., 2013). Moreover, the screening would enable disease prevention by timely detection of PPD.

However, while studies have investigated the cost-effectiveness of PPD screening for mothers (Paulden et al., 2009; Wilkinson et al., 2016), no such study has been completed for fathers. Therefore, the overall aim of this article is to determine if screening fathers for PPD using the EPDS is cost-effective in Stockholm County.

2. Methods

A Markov model is used to determine if it is cost-effective to screen fathers for PPD.

There is some controversy as to whether or not there is just an increase in depression rates during the postpartum period or whether PPD is a distinct phenomenon (Gjerdingen & Yawn, 2007). In the current study, PPD is defined as a father having depressive symptoms occurring within a year after the birth of the child, meaning that costs and health outcomes are based on depression in general and not necessarily specific for PPD. To create the Markov model, the costs and health effects for fathers who received and did not receive a screening will be compared. The threshold value of willingness to pay (WTP) is used to identify the cost-effectiveness by assessing the Gross Domestic Product (GDP) per capita based on recommendations from the World Health Organization (Bertram et al., 2016). Swedish GDP per capita was EUR 47 580 in 2015 (European Central Bank 2017a). The effects in the model are measured in quality adjusted life years (QALYs) (Drummond et al., 2005). QALY is a measure of health that consists of both the time spent in a certain health state and the quality of life. The quality of life is presented as a QALY weight ranging from 0–1, where 0 is no health and 1 is full health. To calculate a QALY, the weight is multiplied with the time spent in that health state (Drummond et al., 2005). An incremental cost-effectiveness ratio (ICER) is then calculated by dividing the incremental cost difference (ΔCosts) by the incremental effect difference (ΔEffects) among the treatment alternatives (Briggs et al., 2006). The cost-effectiveness of a PPD screening model was built using TreeAge Pro 2017 (see Fig. 1).

Since, to the authors' knowledge, there are no previously constructed models using this scenario, a new model was created. The model´s starting stage is set to *becoming a father*. Then *fathers* were divided into *Screening* or *No screening.* In the next stage of the model, the fathers could be classified as *depressed, not depressed* or *dead.* Fathers that were classified as depressed could continue in the model to *treatment* or *no treatment,* and after that they could stay in the health state *depressed* or go to the health state *post-depression* or *dead.*

2.1. Data collection

Literature searches were completed to identify data on health utilities for the different health states and resource utilization, while costs for depression related care, probabilities for new depression, treatment, remission and death were also collected. The searches were conducted using PubMed and Web of Science between December 2016 and April 2017. Colleagues' knowledge, as well as the reference lists of the relevant studies were then further assessed to see if any other data could be accessed. In addition, national Swedish databases including the Social Insurance Agency, The National Board of Health and Welfare, Statistics Sweden and Stockholm County Council were also searched to find costs and resource utilization for depression related care in Sweden, as well as costs for antidepressants and productivity losses.

2.1.1. Eligibility criterion

The general inclusion criterion included: material using only adult populations written in Swedish or English. Specific inclusion criterion for QALYs and costs included: articles with information on costs and/or QALY´s for depression from Stockholm or Sweden.

2.2. Study design

After reviewing potential Swedish data on fathers with PPD Bergström, 2013; Carlberg et al., 2018; Kerstis et al., 2012; Massoudi et al., 2016, Carlberg et al (2018) study was seen as the most potentially valuable data due to its robust sample size of 3656 fathers screened for PPD, as well as because they offered different treatment options, which could be further assessed in alternative scenarios. We therefore, contacted Carlberg et al. and they provided us with their raw data. Their data, which is referenced as Carlberg et al. (2018), was then used for our analyses.

2.2.1. Base case scenario

The base case scenario, consisting of data from Carlberg et al. (2018) study and data identified through literature searches, compared a PPD screening (EPDS screening) for fathers in Stockholm County compared to fathers not receiving a PPD screening. The complete list of the variables included in the model can be found in Tables 1 and 2.

Information about the screened group of fathers was taken from Carlberg et al. (2018) (more information about study population is available online). Those identified as having depressive symptoms were offered, but could refuse, a treatment option (e.g. antidepressants, therapy). It was assumed that fathers in the screened group were invited to a specific father visit at their CHC, where the nurse screened them for PPD. This assumption was made, because starting in 2017, CHCs in Stockholm County implemented a new father visit when the child is between three-to-five months old. A hypothetical control group was created using Carlberg et al. (2018) data, where the data was copied from the screened group, except for receiving the screening and any outcomes and costs derived from that screening. For example the fathers in the screened group had higher probability of getting treatment since they were offered treatment if they showed any signs of depression, compared to those in the no screening group that had to seek treatment on their own (for more information see Table 1).

Since PPD normally occurs between four weeks to 12 months post-delivery (Seyfried & Marcus, 2003; Vigod, 2016), the cycle length of the model is set to one year. In addition, no assumptions regarding the duration of a depressive episode were made; instead we used the average costs and resource utilization for a depressed person over a 12-month period. As the risk for a recurrent depressive episode increases after a first PPD event (Williamson & McCutcheon, 2004), capturing all costs and health consequences require a wide time horizon (Philips et al., 2006). The fathers participating in Carlberg et al. (2018) study were between the ages of 18 and 71, with most men becoming fathers between 30–40 years of age. Thus, after reviewing the mean age for becoming a father in Sweden, a start age of 30 years was chosen (Carlberg et al., 2018; Massoudi et al., 2016; Statistics Sweden 2013), and the time horizon of 10 years was tested in the base case model.

Table. 1
Included variables in Base case model.

Variable	Value	Source
Health utility weights		
Depression	0.40	Burström et al. (2001a)
Post-depression	0.81	Sobocki et al. (2006)
Cost €		
Psychologist	57	Sobocki et al. (2007a), Co-operation Stockholm county council and Region Gotland 2016
Hospitalization	1047	Ekman et al. (2013)
Screening	14	Statistics Sweden (2015b), The Swedish tax agency (2017)
Probability		
Depression	0.08	Carlberg et al. (2018)
No depression	0.92	Carlberg et al. (2018)
New depression episode	0.09	Carlberg et al. (2018), Mueller et al., (1999)
Treatment in No Screening	0.35	Wallerblad et al. (2012)
No treatment in No Screening	0.65	Wallerblad et al. (2012)
Treatment in Screening	0.89	Carlberg et al. (2018)
No treatment in Screening	0.11	Carlberg et al. (2018)
Remission after treatment	0.47	Hollon et al. (2014)
Remission after no treatment	0.41	Whiteford et al. (2013)

2.2.2. Structure of the model

The base case model includes the following health states: *no depression, depression, post-depression* and *death.* The *depression* state was identified using the EPDS screening tool. We used an EPDS score of 12 or higher for the base case analysis, as it identifies major depressive symptoms in fathers (Massoudi et al., 2013). Therefore, fathers who had an EPDS score lower than 12 were identified as not depressed and were consequently included in the *no depression* state. Previous studies have shown that both the risk for recurrent depressive episodes (Kessing & Andersen, 1999; Sobocki et al., 2006), as well as the QALY weight (Sobocki et al., 2006) can be different for patients after a depression compared to those who never had a depression. Therefore, a *post-depression* state is included in the model, with a higher risk for a recurrent depressive episode and lower QALY weights than in the health state *no depression*. The terminal health state *death* affects fathers who died during the time horizon.

2.2.3. Costs

The present study was performed using a societal perspective and accounts for direct and indirect costs related to depression. Since the treatments for PPD are the same as those diagnosed with general depression (Stewart & Vigod, 2016); we used general treatment of depression when calculating costs. The costs for the screening and the no screening groups are identical, except for the cost of the screening, which is only assumed for the screened group. All costs were inflated to 2016 years' prices based on the consumer price index (CPI) (Statistics Sweden 2017a), and then converted to euros based on the average European Central Bank conversion rate during 2016, where 1 euro equalled 9.4689 Swedish kronor (European Central Bank 2017b).

2.2.4. Inpatient and outpatient care

The inpatient care cost was defined as the average psychiatric hospitalization cost for depression and these costs were retrieved from Ekman et al. (2013) who analysed the societal cost of depression in Stockholm. The total inpatient care costs were obtained by multiplying the average resource utilization of inpatient facility (1.7 days) by the inpatient care costs per day (€ 585) (Ekman et al., 2013).

The outpatient care costs include a counselling visit with a psychologist and a visit to the general practitioner (GP) within the

Table. 2
Age dependent variables included in the model.

Age group	Health utility weights Healthy population	No. of GP visits	Cost GP (2016) €	Cost antidepressant Males per patient Stockholm County (2016) €	Productivity losses Depressed men in Stockholm County (2016) €
< 19	0.91	2	404	76	138
20–24	0.91	2	404	76	6021
25–29	0.91	2	453	76	10 332
30–34	0.90	2	414	76	13 756
35–39	0.90	3	484	76	16 478
40–44	0.86	2	455	76	19 618
45–49	0.86	3	505	86	20 204
50–54	0.84	2	464	86	19 536
55–59	0.84	3	497	86	17 917
60–64	0.83	3	482	86	14 351
65–69	0.83	2	430	75	4548
70–74	0.81	2	484	75	1163
75–79	0.81	2	366	57	–
80–84	0.74	2	413	57	–
85+	0.74	–	–	–	–
Source	*Burström et al. (2001b)*	*The National board of health and welfare (2015b)*	*Hälso och sjukvårdsförvaltningen 2017*	*The national board of health and welfare (2015a)*	*The social insurance agency 2017, Statistics Sweden (2015a)*

Stockholm County Council. Both costs were obtained from the Stockholm County Council pricelists for 2016 (Hälso och sjukvårdsförvaltningen 2017). The total outpatient care costs were obtained by multiplying the average resource utilization of outpatient care visits by the visit costs. The average resource utilization for a psychologist visit (0.18) (Sobocki et al., 2007a) was multiplied with the cost (€ 316) (Hälso och sjukvårdsförvaltningen 2017), and the cost of a GP visit was multiplied with the age-differenced utilization (see Table 2).

2.2.5. Antidepressant costs

The costs for antidepressants are defined as the age and gender differentiated total yearly costs for antidepressant medications per patient in Sweden for 2015, which were then inflated to 2016 prices, and were obtained from The National Board of Health and Welfare's (2015a) website.

2.2.6. Productivity losses

The productivity losses in the analysis have been valued according to the human capital method, as this is commonly used when making assessments from a societal perspective (Drummond et al., 2005). Productivity losses were calculated based on sick leave days taken and monthly income. The average yearly sick leave for depressed men in Stockholm for 2015 was extracted from The Swedish Social Insurance Agency (2017). The average annual income for men in Stockholm older than 20 was retrieved from Statistics Sweden (2015a) and the payroll tax of 31.42% (The Swedish Tax Agency 2017) was added to the monthly income. To calculate daily earnings, the annual income was first divided by 52 (weeks), and then further divided by five (days). To obtain the average yearly productivity loss estimate per person, the daily income was then multiplied by the total number of yearly sick leave days per person (105 sick days; The Swedish Social Insurance Agency 2017).

2.2.7. Costs of screening

The cost of screening is assumed to be the sum cost of nurses´ time and the payroll taxes. The average monthly salary for a CHC nurse for the year of 2015 in Sweden was collected from Statistics Sweden (2015b) and transformed into 2016 prices using the CPI. The payroll taxes of 31.42% (The Swedish Tax Agency 2017) were then added to the monthly income to estimate the total cost. To calculate the hourly salary, the monthly income was divided by 160, which defines the average working hours for full time workers. The hourly salary was then divided by two to measure the cost for a 30 min visit, which is the estimated time for completion of the EPDS, plus follow-up discussions (Centrala mödra- och barnhälsovården i Göteborg 2004). Since the mean number of children in Sweden is 1.8 (Statistics Sweden 2017b), two screenings were accounted for in the model.

2.2.8. Resource utilization

The data regarding depression related resource utilization is defined as: (I) age-differentiated mean number of visits to the GP for depressed men between the ages of 20–84 in primary care facilities in Stockholm County (The National Board of Health and Welfare 2015b), (II) mean number of visits to a psychologist for a depressed patient between the ages of 18–89 in primary care facilities in Sweden (not age-differentiated) (Sobocki et al., 2007a), and (III) mean number of inpatient days in the psychiatric facility for depressed men over 18 years of age in Stockholm (not age-differentiated) (Ekman et al., 2013).

2.2.9. QALY

Each health state in the Markov model was assigned a QALY weight defined from the health utility weights identified in the literature. The QALY weights for the health states *depression* and *no depression* were taken from Burström et al. (2001a) and Burström et al. (2001b). The QALY weight for the *depression* state is the average sex differentiated weight for males between 16–84 years (Burström et al., 2001a), while the QALY weights for the *no depression* state are age and sex differentiated for males between ages 20–88 (Burström et al., 2001b). For *post-depression* health state, we used the QALY weight from Sobocki et al. (2006) representing the average health-related quality of life of the patients between the ages 18–89 who had remission from depression.

2.2.10. Discounting

People tend to value money (and health) in the present higher than in the future (Drummond et al., 2005). Since, in economic evaluations, it is common to investigate both health and costs that can occur in the future, it is recommended to discount both health utilities and costs that occur in the future (Drummond et al., 2005). The costs and health utility weights were discounted using a three percent yearly discount rate as recommended by The Pharmaceutical Benefits Board (2003).

2.2.11. Transition probabilities

The depression rate from Carlberg et al. (2018) was analysed using SPSS. The already existing EPDS scores were recoded into new variables based on EPDS scores ≥ 12. The number of depressed and non-depressed fathers was then identified using descriptive statistics and the percentage of fathers accepting the treatment option was also identified. The probabilities for receiving treatment for the unscreened group were identified from the literature (Wallerblad et al., 2012). Those with depression had an 18% increased probability of recurrence (Mueller et al., 1999). All above-mentioned variables are presented in the form of probabilities. When data are identified as a rate, the following formula is used to transform it into a probability (Briggs et al., 2006).

$$p = 1 - e^{-rt}$$

The probability of death for non-depressed fathers was defined as the average yearly age-differentiated death rate for men in Stockholm County and obtained from The National Board of Health and Welfare (2015c). In the base case analysis, the death rate for men aged 30–40 years was used. The death rates for men with PPD were assumed to have a higher mortality of 3.34 times increased death hazard from depression (Stromberg et al., 2013), while those in the *post-depression* state were assumed to be the same as death rates for non-depressed fathers.

2.2.12. Treatment effects

Remission signifies the state of *no depression* after one cycle. The remission rate for treatment was taken from a randomized controlled trial with a 12-month follow-up for both therapy and antidepressants (Hollon et al., 2014). The quality of the study was evaluated using the CONSORT checklist (Schulz et al., 2010). The rate for remission after no treatment was identified in a systematic review and a meta-analysis (Whiteford et al., 2013). The quality of the article was evaluated using the AMSTAR checklist (Shea et al., 2007).

2.3. Sensitivity analysis

Different scenarios of one-way sensitivity analyses were tested in accordance with the ranges identified in the literature (for more information see supplementary information online). In cases where the range data was unavailable, the upper and lower values were identified by applying a 50% change to the initial values. A probabilistic sensitivity analysis (PSA) was also performed, using the probability distribution, to account for joint uncertainty in the model parameters (Briggs et al., 2006) (for more information see supplementary information online). The results of the PSA are shown in a cost-effectiveness plane, which is a four-quadrant diagram showing the difference in costs and effects between different options. The cost is presented on the vertical axis and the effects on the horizontal axis. Therefore, the lower down the results are on the vertical axis, the lower the costs, while the further right on the horizontal axis, the greater the effects (Drummond et al., 2005). The distributions were defined by the mean and standard deviation of the original variable. If the standard deviation was not provided, it was calculated using the range/6 formula (Hozo et al., 2005).

2.4. Alternative scenarios

Supplementary alternative scenario analyses were performed to challenge the assumptions made in the base case scenario. First, to examine if the screening is cost-effective regarding different timeframes, the cost-effectiveness analysis is also performed using time horizons varying between two years and a person's lifetime. All other variables were the same as in the base case model. The lifetime perspective analysed the input variables between ages 18–100. When the age-differentiated variables cannot be obtained, an average value for the variable is used. When the full dataset between ages 18–100 cannot be obtained, the next closest value is assumed to represent the age group. Second, to examine the robustness of the model, depression probabilities for paternal PPD from Swedish studies by Massoudi et al. (2016) and Bergström (2013), and a global meta-analysis by Paulson and Bazemore (2010) are further assessed, with all other variables being the same as in the base case analysis (for more information see supplementary information online).

Lastly, since Carlberg et al. (2018) used multiple outcomes, a cost-effectiveness analysis using their alternative outcomes, such as a self-help book or, on average, four counselling sessions with a psychologist, are further examined. The probabilities of recurrence rates are based on their one-year follow-up estimates of depressed fathers (Carlberg et al., 2018). The group that received the self-help book and the group that received counselling had these additional costs, respectively, added to their total costs. In this scenario, fathers in the screening groups are assigned recurrence rates (Carlberg et al., 2018), while the control group maintained the remission rates from the literature. The recurrence rates were calculated by dividing the number of depressed fathers within the different treatment options at 12 months follow-up by the total number of depressed fathers at 12 months. This number was then transformed into a probability measure.

3. Ethical considerations

Since the current study only used secondary data, no ethical approval was required.

4. Results

Using an EPDS cut-off score of 12 or higher, 8% of the screened fathers are classified as having depressive symptoms, and 89% of those with depressive symptoms accepted treatment.

The base case analysis resulted in a negative ICER (– 35 567), indicating that postpartum screening for fathers could be cost-effective with regards to the WTP threshold of €47 580. The screening cost totalled €28 494 compared to the no screening cost of €29 561. The screening led to an increase in QALY´s of 0.03. The screening was shown to be beneficial by demonstrating a decrease in costs and an increase in QALY´s. This means that the screening program dominates the no screening program.

4.1. Sensitivity analysis

One-way sensitivity analysis was performed on the variables included in the model (see supplementary data). The tornado diagram depicted in Fig. 2 shows the results of the analyses, with the variables that have most impact on the results at the top of the diagram. Therefore, the results of the one-way sensitivity analysis show that the cost-effectiveness of screening, as opposed to no screening, was most sensitive regarding the following variables: QALY for the depressed patients, probabilities of remission in treatment and no treatment groups, start age, and productivity losses.

Analysing Monte Carlo simulation with 1000 iterations in the PSA resulted in a cost-effectiveness plane displaying a higher density of ICERS positioned in the south-east quadrant, meaning that the screening option was dominant in most cases. With the cost-effectiveness probability identified after the WTP threshold value of €47 580, the screening option indicated cost-effectiveness 70% of the time. The variables tested in the PSA are available as supplementary data. (Fig. 3).

4.2. Alternative scenarios

4.2.1. Alternative scenario 1

A cost-effectiveness analysis is also performed with different time horizons. For all time horizons tested, the screening alternative is associated with lower costs and generated similar or larger effects compared to the alternative of no screening (Table 3). The biggest cost difference between the two alternatives is found with a time horizon of

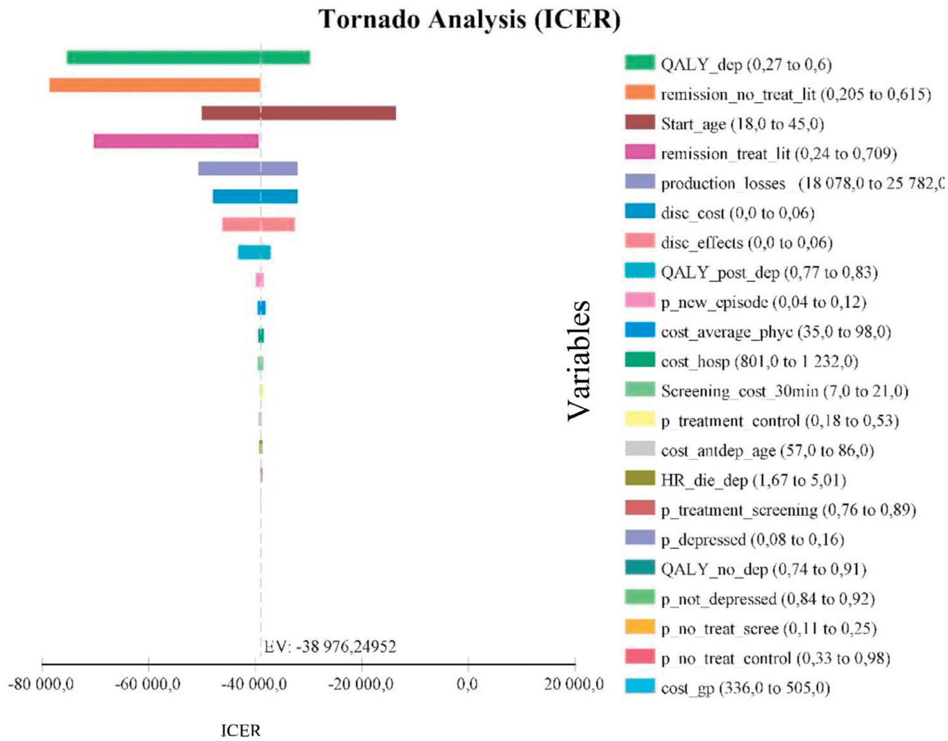

Fig. 2. Tornado diagram showing the variables that affect the Incremental Cost-Effectiveness Ratio (ICER) from most to least.

40 years. Nonetheless, the difference in costs is similar for time horizons from 30 years to lifetime (€3224–€3546). A time horizon of two years shows no significant difference in effects, while the time horizon of lifetime is associated with the biggest difference of 0.12 between the effects of the two alternatives.

4.2.2. Alternative scenario 2

To check the robustness of the model, the following PPD probabilities were tested: I) Probability of 6.3% retrieved from a population-based study of 885 fathers from a southern Swedish region (Massoudi et al., 2016), II) Probability of 10.3% from a nationwide Swedish randomized control trial (Bergström, 2013), and III) Probability of 10.4% from a meta-analysis of 16 studies globally (Paulson &

Table. 3
Different time horizons.

Time horizon	Screening Cost €	Screening Effect	No screening Cost €	No screening Effect	Δ Cost €	Δ Effect	ICER
2 years	6203	2.45	6264	2.45	60	0.00	Dominated*
5 years	14 201	4.6	14 583	4.59	382	−0.01	Dominated*
20 years	55 483	12.44	57 924	12.39	2441	−0.05	Dominated*
30 years	73 721	15.81	77 055	15.74	3334	−0.08	Dominated*
40 years	79 943	18.09	83 489	18	3546	−0.09	Dominated*
50 years	80 764	19.42	84 261	19.31	3497	−0.11	Dominated*
Lifetime	77 440	21.84	77 664	21.72	3224	−0.12	Dominated*

* No screening programme is dominated by the screening program.

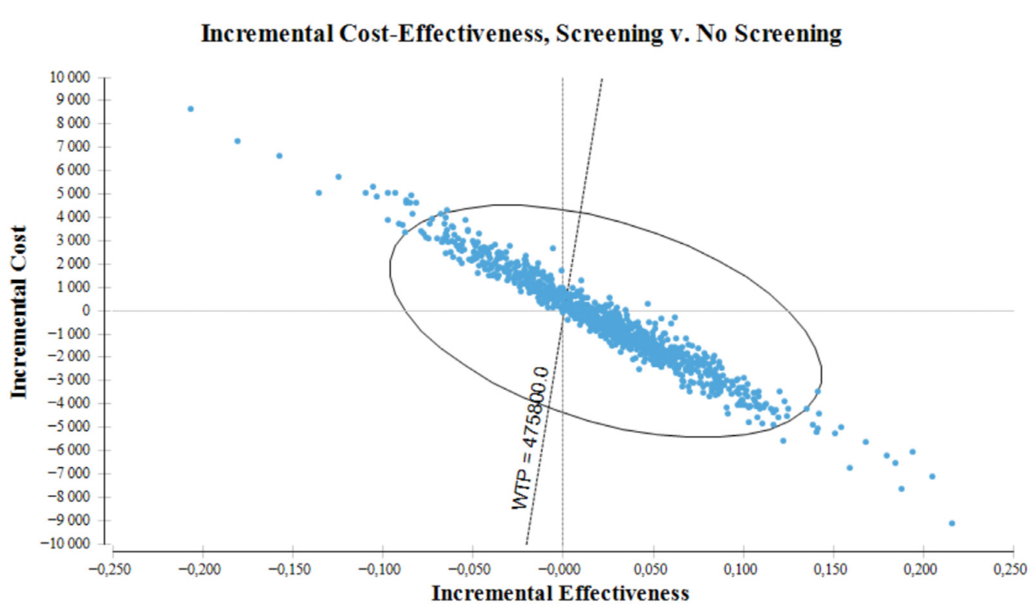

Fig. 3. Cost-effectiveness plane showing the scatterplot of the probabilistic sensitivity analysis.

Table. 4
Additional variables used in alternative scenario 3.

Variable	Value	Source
Cost €		
Self-help book	18	Carlberg et al. (2018)
Counselling	1263	Carlberg et al. (2018), Co-operation Stockholm county council and Region Gotland 2016
Probability		
Treatment counselling	0.45	Carlberg et al. (2018)
Treatment self-help book	0.44	Carlberg et al. (2018)
Recurrence after counselling	0.23	Carlberg et al. (2018)
Recurrence after self-help book	0.21	Carlberg et al. (2018)
Recurrence after no treatment	0.40	Carlberg et al. (2018)

Bazemore, 2010). The results for all three alternatives indicated that the screening intervention was cost effective and dominated the no screening option (for more information see the supplementary data).

4.2.3. Alternative scenario 3

Table 4 shows the different data inputs used in the alternative scenario, which was the approximation of the intervention carried out by Carlberg et al. (2018). All remaining data inputs were assumed to be the same as in the base case analysis. The results of the cost-effectiveness analysis from Carlberg et al. (2018), was similar to the base case analysis. The results indicated that the screening alternative was cost-effective and dominating, since it was associated with lower costs (€ 20 608 compared to € 29 828) and higher health effects (7.85 compared to 7.67). This alternative scenario analysis also resulted in the biggest difference in costs and effects in favour of the screening program.

5. Discussion

The current study examined the cost-effectiveness of PPD screening in Stockholm County, Sweden using a Markov model. From a societal perspective, the results show that screening fathers was cost-effective and dominating compared to no screening. The screening in the base case analysis resulted in a lower intervention cost of €28 494 and higher health effects equal to 7.70, with a result gain of 0.03 QALY´s. Alternative scenarios were further examined and were also cost-effective. The analysis of time horizons ranging from two years to lifetime show that screening generates the most health effects when using a lifetime perspective.

Furthermore, a supplementary analysis was conducted for a model maximally adjusted to the Carlberg et al. (2018) study, where a self-help book, as well as counselling was used. These results yielded the highest gains in health effects of 0.19 compared to the base case and alternative scenarios; therefore, different treatment effects impact the cost-effectiveness. As the treatment effects define the movement of the depressed patients to the final stages of *depression, post-depression* or *death*, according to the essence of Markov decision process, they can highly affect the final costs and effects of the intervention.

The current results show that screening fathers for PPD could be cost-effective. However, previous cost-effectiveness research on screening mothers for PPD has shown mixed results (Paulden et al., 2009; Wilkinson et al., 2016). Comparing the studies, while the prevalence of depression was similar in both articles, Wilkinson et al. (2016) analysed their model using a two-year time horizon and the health care costs were assumed to originate from the United States with the Medicaid healthcare payer perspective. On the other hand, Paulden et al. (2009) analysed their model using a one-year time horizon and assumed the perspective of the National Health Service in England, as well as the personal social services. Therefore, it can be postulated that cost-effectiveness is subject to the model structure and setting.

5.1. Public health implications

Even though PPD is prevalent among fathers (Bergström, 2013; Massoudi et al., 2016; Paulson & Bazemore, 2010), and has negative long-term consequences on the individual, family (Goodman, 2004; Kane & Garber, 2004; Paulson & Bazemore, 2010; Ramchandani et al., 2005; Seto et al., 2005; Williamson & McCutcheon, 2004), and for society (Edoka et al., 2011), the Swedish screening program for PPD is only recommended and routinely available for mothers (The National Board of Health and Welfare 2016). The lack of screening and supporting fathers throughout the Swedish child health services may be because current screening tools, like the EPDS, do not fully capture depressive symptoms in fathers (Massoudi et al., 2013). However, another potential reason could be because fathers, or any non-birthing parent (Wells & Lang, 2016), are not seen as patients within Swedish child health field (Wells, 2016; Wells & Sarkadi, 2012). In addition, while most CHC nurses do view fathers as equal parents, many do not feel they have the competency to meet and support both parents (Wells et al., 2017). Since the current results show that screening fathers for PPD is better than not screening fathers (e.g. it could be cost-effective), clinicians working with new fathers should consider routinely screening fathers for the benefit of the child, father, and family.

Timely identification and treatment has shown to lead to decreases in depression prevalence (Halfin, 2007), which in turn has enabled fathers to enjoy a higher QALY, leading to healthier lifestyles, being more productive at work (Ramchandani et al., 2005; Ramchandani et al., 2008; Ramchandani et al., 2013), more involved with their family and reduced adverse child outcomes (Ramchandani et al., 2005; Ramchandani et al., 2008; Ramchandani et al., 2013).

5.2. Methodological considerations

5.2.1. Strengths

A strength to this article is that previous studies have not conducted a cost-effectiveness analysis of screening fathers for PPD. In addition, the uncertainty in the estimated results of the current cost-effectiveness model was addressed through one-way sensitivity analysis and PSA. Modelling uncertainty (Briggs, 2000) was addressed through adjusting the model to Carlberg et al. (2018) intervention that included a self-help book and counselling as treatment options, as well as a 12-month follow-up. Similarly, after applying depression prevalence rates from Bergström (2013), Massoudi et al. (2016), and Paulson and Bazemore (2010), the screening model still indicated cost-effectiveness and domination; thus, demonstrating the robustness of the model, and therefore it might be transferable to other settings. However, future research should further examine the cost-effectiveness of screening fathers, as well as mothers, for PPD. In addition, future cost-effectiveness studies may want to focus on more general mental health problems, such as distress, which would include anxiety issues, as they are also relatively prevalent in new fathers (Wynter et al., 2013).

5.2.2. Limitations

Since this study is based on fathers in Stockholm County, the current study may not be generalizable. However, different prevalence rates were tested (Bergström, 2013; Massoudi et al., 2016; Paulson & Bazemore, 2010) and found to be cost-effective.

The sensitivity analysis showed that the treatment effects applied to the cost-effectiveness model had significant effects on the ICER. To access the quality of the evidence, the articles where treatment effects originated from were accessed with the corresponding quality assessment tools (Schulz et al., 2010). Nonetheless, it should be noted that the final result of the model might have been different if the treatment effects were retrieved from other studies.

Another potential limitation with this study is that the screening cost is assumed to be equal to the cost of the nurses' time. However, the administration costs and training costs of using a PPD screening tool on fathers were not included in the model. The exclusion of these costs was decided since nurses already use the screening tool for mothers, and a separate father visit is currently being implemented at CHCs in Stockholm County. However, to account for this potential limitation, these screening costs were tested in the sensitivity analyses, which showed that variability in the screening cost did not have a significant impact on the ICER.

As the productivity losses in the current model have been calculated according to the human capital approach, they might have been overestimated (Drummond et al., 2005). An alternative method is the friction cost approach, which supports the employer´s perspective, and accounts for the productivity losses for the individual until the person is replaced by another worker (Drummond et al., 2005). However, these two approaches tend to produce similar productivity loss results when losses are under six months (van den Hout, 2010). Since the current study assumes the yearly work absenteeism of 105 days (approximately 3.3 months) (The Swedish Social Insurance Agency 2017), using either approach should not have a significant effect on the final model.

Another limitation with this study is that even though the EPDS tool is validated for screening fathers for PPD, there are some indications that the EPDS might be more suitable to detect distress than depression in fathers (Massoudi et al., 2013). However, Massoudi et al., (2013) showed that with EPDS ≥ 12, the sensitivity of the tool is equal to 100%, while the specificity is 95%.

6. Conclusions and recommendations

The cost-effectiveness analysis of a PPD screening for fathers in Stockholm County showed that the PPD screening intervention could be cost-effective and dominate the no screening option from a societal perspective. The analyses of different scenarios showed that the model still indicated cost-effectiveness and domination when the different time horizons, depression probabilities and treatment options were tested. This indicates that the implementation of the screening program could provide a good value for money and improve the QALY for fathers suffering from PPD and their families. Based on the findings of the current study, healthcare decision makers should be encouraged to implement, and governing institutions to recommend, a postpartum screening intervention for fathers and by doing so, maximize the efficient resource allocation.

Conflicts of interest

The authors state that there are no conflicts of interest.

Contributors

Michaela Modin Asper and Nino Hallén collected and analyzed the data, as well as contributed to writing every section of the article. Lene Lindberg, Anna Månsdotter and Michael B. Wells helped with the data collection, as well as aiding Michaela and Nino is data analysis. All authors helped with writing every section of the article, as well as with revisions. Magdalena Carlberg helped provide some data, as well as reviewed the manuscript and provided feedback on the article.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Highlights of limitations

- The study uses secondary data, rather than primary data in its health economics model. The study had to be done this way, as the manuscript argues the need for routinely screening fathers. Only after that policy changes could there be an analysis on real-world data related the cost-effectiveness of screening fathers for depression in the postnatal time period. The current study only focuses on Stockholm County, Sweden, and so results may not generalize to other countries who have different health care costs for depression during the postnatal period.
- Since the study is based on fathers in Stockholm County, the current study may not be generalizable. However, different costs, as well as different prevalence rates of fathers with depression in the postnatal period were examined.

Acknowledgments

Special thanks to Niklas Zethraeus for provision of the TreeAge License. The authors would also like to thank Korinna Karampampa for her provided consultation. The authors further give special thanks to Lisa Wellander for challenging our assumptions and providing support and encouragement to us throughout the process.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2018.07.044.

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