Affordability of programmes to prevent spontaneous preterm birth in Austria: a budget impact analysis

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Background: Preterm birth is a rising health problem in Europe generally, and in Austria specifically. Decision makers require objective information on the effects and costs of measures to prevent preterm birth. Methods: We undertook a budget impact analysis from a public payer perspective and for a 1-year and 5-year time horizon for five prevention approaches to reduce preterm birth. Results: Programme costs range from below €50 000 (cervix screening in high-risk pregnancy) to €500 000 (universal infection screening). The lowest health effects demonstrated the largest effect (−230 preterm births per year), whereas infection screening demonstrated the largest cost savings (−€13 million per year). In the sensitivity analyses, preterm birth costs, target group size and (partly) unit costs of programme components have an influence on potential cost savings. However, except for two programmes, the results are robust concerning an overall economic net benefit of the programmes analysed compared with no programme. The study is mainly limited by the quality of some cost data and choice of the reference scenario. Conclusion: When considering potential cost savings, the five prevention programmes analysed seem affordable, with cervix screening and infection screening likely being the most promising in Austria.

Introduction

Preterm birth has been identified as a major public health issue around the world. According to a recent WHO report, preterm birth rates are increasing in almost all countries worldwide. Possible reasons for this include increases in maternal age and underlying maternal health problems, such as diabetes or hypertensive disorders, the rising use of infertility treatments resulting in premature births before term. Prematurity, which is often inter-related with small-for-gestational-age babies, is the leading cause of newborn deaths. Furthermore, premature birth is associated with high short-term and long-term costs.

A number of predisposing factors have been identified as being associated with preterm birth. These include demographic and lifestyle factors (e.g. maternal age, low socioeconomic status, ethnicity, obesity, substance abuse, stress and lack of social support) and ‘medical’ risk factors, such as multiple pregnancies, prior preterm birth or pregnancy termination, vaginal infections and chronic conditions, such as diabetes, high blood pressure or coagulopathy. There is also a genetic influence. However, the precise cause often remains unidentified. In Austria, recent data have indicated rising rates of preterm births. Between 1999 and 2010, the percentage of preterm-born children with a birth weight below 2500 g rose from 6.5 to 7%, relating to an absolute number of 5048–5549 of 78 138 and 78 742 total live births, respectively. In total, 10.9% of children were born <37 weeks of gestation. According to this data, Austria has a high preterm birth rate compared with other European countries.

Recently, child health has become a top priority on the political agenda and resources have been devoted to developing preventive maternal and child health programmes that address current needs. Health policy makers and decision makers, therefore, require objective and transparent information about effective measures on how to prevent preterm birth. Furthermore, against the backdrop of limited resources, they need information on the efficiency, costs and affordability of such measures.

A vast number of high-quality systematic reviews evaluating the impact of different antenatal approaches on preterm birth exist. They have recently been summarized in an overview. Furthermore, there are some economic evaluations on these measures, which have also been summed up in review. While no benefit (e.g. repeated digital cervical assessment for risk assessment) or negative effects (e.g. oestrogen supplementation) with respect to preterm birth were demonstrated for the majority of interventions, some approaches were identified as promising in terms of efficacy and cost effectiveness (e.g. lower genital tract infection screening, progesterone injection in women with prior preterm births).

To address the affordability of such programmes, this article presents the results of a budget impact analysis on measures to prevent preterm births <34 weeks in Austria that have been selected from among these promising approaches.

Methods

Selection of measures to prevent preterm birth

On the basis of the two systematic literature reviews on the effectiveness and cost effectiveness of measures to prevent preterm birth mentioned earlier, we first selected approaches that promised to be effective and—if economic evaluations were available—cost effective. Working together with national medical experts, a consensus was reached on five approaches to be selected for the budget impact analysis, which are based on the criterion of feasibility and take into account the characteristics of pregnant women in Austria: (i) screening for shortened cervix of pregnant women at risk of preterm birth (previous spontaneous preterm birth) and vaginal progesterone application; (ii) progesterone injection for pregnant women at risk of preterm birth (previous spontaneous preterm birth); (iii) polyunsaturated fatty acid supplementation.
(‘fish oil’) for pregnant women at risk of preterm birth (previous spontaneous preterm birth, smokers, status post-growth retardation); (iv) smoking cessation for pregnant smokers (cognitive behavioural approach and ‘feedback approach’) and (v) universal screening for asymptomatic vaginal infection. Details on the programmes are presented in Table 1.

**Methodological details of the budget impact analysis**

We undertook a budget impact analysis according to methodological standards, where we compared each of the five programmes with the alternative ‘no preventive measure’. The latter was chosen because although preventive measures are already in place to some extent, they are provided inconsistently and partly for target populations that are not evidence-based (e.g. for all pregnant women, in contrast to those with previous preterm births). Hence, it was assumed that the monetary benefits will currently be outweighed by additional costs elsewhere. The budget impact was calculated for a 1-year and 5-year time horizon from a public payer’s perspective in an undiscounted form. This implies that we measured direct costs only. According to the Austrian Manual on Health Technology Assessment, one-time costs for investment and the establishment of a programme are not included in the calculation.

In detail, we first estimated the costs for each programme and added the costs for preterm births. The total costs for preterm birth with and without the preventive measure were derived by estimating the expected numbers of preterm births <34 weeks of gestation with and without the preventive measure based on decision trees (see Appendix 1, Supplementary material online for details). The number of preterm births with and without the preventive programme was multiplied by the unit costs of preterm birth. The budget impact was calculated by demonstrating the resulting total costs for the preventive measures compared with the alternative ‘no preventive measure’. As a final result, potential savings or extra costs were displayed.

**Data sources and sensitivity analysis**

Data sources for effectiveness were systematic reviews on effectiveness supplemented by assumptions when data were lacking. Data sources for the type of resources used were clinical guidelines, data from the systematic review on economic evaluations and expert opinions on the state of the art of service supply. Information on the quantities of resources required was derived from birth registry data and from a review on epidemiological data that gave us in Appendix 2 (Supplementary material online). Values and ranges, as well as their sources are available in the epidemiological data that gave us opinions on the state of the art of service supply. Information on the Appendix 2 (Supplementary material online). All parameters that were uncertain or based on assumptions were varied in one-way sensitivity analyses. A total list of parameters that were used for the intervention and the reference scenarios, their values and ranges, as well as their sources is available in the Appendix 2 (Supplementary material online).

**Results**

**Base-case results**

Table 1 illustrates the costs for the different preventive programmes, the total costs, the cost differences to the alternative ‘no preventive programme’ and the number of preterm births prevented. The figures refer to the results from the base-case analysis.
Concerning direct programme costs, the lowest costs have been estimated for the programme ‘cervix screening’ (€34 000 per year). The most expensive programme is the universal infection screening (€500 600). All other programmes cost between €100 000 and €200 000 per year in the base-case analysis.

According to the base-case results from the decision tree analysis, the largest numbers of preterm births <34 weeks are to be prevented by the universal infection screening, where more than 200 fewer preterm births per year have been estimated. This would equal 1200 fewer preterm births in 5 years. The smoking cessation programmes are associated with the lowest numbers of prevented preterm births (<15 in 1 year and <70 in 5 years). The remaining programmes have resulted in an estimated number of 60–100 preterm births prevented in 1 year and 300–450 in 5 years.

Total costs (costs of preterm birth plus costs of preventive programmes) are largest for the smoking cessation programmes, being around €22 and €117 million for 1 year and 5 years, respectively. The lowest total costs have been calculated for the programmes ‘cervix screening’ and ‘progesterone injection’ (€12 million in 1 year and €62 million in 5 years). Fish oil supplementation would result in total costs of €17 and €91 million in year 1 and after year 5, respectively, whereas the universal infection screening programme would amount to roughly €20 and €100 million in the two time periods covered.

The cost differences between the prevention programme and the alternative ‘no preventive measure’ in the base-case analysis are all in favour of the preventive measures. This means that when taking the costs of preterm births avoided into account, the prevention programme is overall less costly than doing nothing. We estimated the largest cost difference for the universal infection screening programme (€13 million in 1 year and after 5 years, respectively). The smallest cost difference has been demonstrated for the smoking cessation programmes, where the potential savings are around €500 000 in year 1 and five times this amount in year 5. In the remaining programmes, the differences lie between −€3 and −€5 million in 1 year and between −€19 and −€28 million after 5 years.

Sensitivity analysis

We varied uncertain parameters in sensitivity analyses. Uncertain parameters were those that were either based on assumptions due to lack of detailed data (e.g. unit costs for new services which have not existed so far), which showed wide intervals, for example, due to different values presented in the literature (e.g. for cost of preterm birth) or that were from international sources (e.g. probability for cervix length ≤15 mm). The parameters finally chosen for sensitivity analysis include the programmes’ effectiveness, the hospital costs of preterm birth, uptake of and/or compliance to the programmes, the size of the target population and unit costs of service components within the preventive measure in cases where detailed tariffs were missing. In addition, we ran the model with a best case and a worst case scenario. The best case and worst case scenarios combine parameter values with respect to size of the target group, programme effectiveness and hospital costs of preterm births in their most optimistic and most pessimistic values, respectively.

The ranges in terms of expected preterm births prevented are presented in table 2 for a 1-year and 5-year perspective. Depending on the type of programme, the lower range for the reduction of premature births ranges from −3 (smoking cessation) to −229 (infection screening) in year 1 and from −14 to −1144 in year 5. In the best case scenarios, between 21 and 248 prevented preterm births have been estimated in year 1, corresponding to 104 and 1238 fewer preterm births in year 5.

Figure 1 illustrates the variations in total cost differences between the preventive measure and the alternative ‘no preventive measure’ for a 5-year time horizon. The results show that the hospital costs of preterm birth considerably influence the cost differences regardless.
of prevention programme. Lower hospital costs reduce the potential savings. In the ‘smoking cessation programmes’ and in the ‘fish oil programme’, results are additionally influenced by the size of the assumed target group. The larger the treated population, the larger the potential savings are. The unit costs of specific screening or treatment elements have varying influence on the total cost differences. While higher costs of infection screening increase the programme costs from \( \text{€500 000 to €2 million per year} \), while the most expensive alternative would be a universal infection screening, costing between \( \text{€500 000 and €2 million} \), depending on the size of unit costs assumed.

If single measures are introduced, preterm births <34 weeks are expected to be reduced by a maximum of 248 per year, which equals 11% of all preterm births <34 weeks. Yet, because of the large costs of premature birth—except for very few pessimistic scenarios in the ‘fish oil programme’ and ‘CBT-smoking cessation programme’—all preventive measures are, in total, less costly than not implementing a prevention programme. Because of the larger number of expected prevented preterm births, the biggest cost savings can be expected from universal infection screening, whereas the lowest potential savings have been estimated for the smoking cessation programmes.

Comparison with international and other national studies is limited, as the existing literature addresses cost effectiveness but not the budget impact of measures to prevent preterm births.\(^{15–21}\) The cost-effectiveness results seem to complement the results of our analysis, as they consistently favoured the preventive measure analysed. However, only one study\(^{16}\) compared all relevant alternatives in their economic evaluation and the transferability of cost-effectiveness results to Austria is limited.

The study has a number of limitations. First, because the purpose of a budget impact analysis is to analyse the affordability of a technology, our results are of limited value for resource allocation decisions in terms of efficiency. For that purpose, an economic

**Discussion**

In this article, we presented a budget impact analysis for five approaches to prevent preterm birth of <34 weeks of gestation. The results have shown that the different programmes vary greatly in regard to programme costs, preterm births prevented, total costs and potential cost savings.

The cheapest option seems to be to implement a cervix screening programme for women with previous spontaneous preterm births (below \( \text{€500 000 per year} \)), while the most expensive alternative would be a universal infection screening, costing between \( \text{€500 000 and €2 million} \), depending on the size of unit costs assumed.

Figure 1 Sensitivity analyses results: variations in cost differences (5-year time horizon)
evaluation (e.g. cost-effectiveness analysis) would be required, thus
taking a broader range of health effects (e.g. morbidity, mortality
and quality of life) and a different time horizon into account. Our
hypothesis, which still needs to be confirmed, is that the
cervix screening programme and the infection screening
programme seem to dominate the ‘fish oil approach’, the two
smoking cessation programmes and the ‘progesterone injection
approach’.

The second limitation refers to the costs included in our
analysis. Some of the cost data used are uncertain, which has,
however been accounted for in the sensitivity analyses. Moreover,
the costs for programme implementation and one-time investments
have been neglected, meaning that the true public expenditure
for the programmes will actually be higher than in our analysis.
Yet, this is counterbalanced by not including long-term costs of
premature births due to the lack of reliable data. In this case,
our results are biased against the intervention, as higher costs
of preterm birth would have resulted in even higher potential cost
savings.

Third, the cost savings need to be interpreted with caution,
because existing infrastructure and personnel cannot immediately
be reduced in the case of decreasing numbers of preterm births.

Fourth, the alternative scenarios chosen (‘no preventive measure’)
may not totally reflect the real-world situation in Austria, as many of
the measures analysed may already have been implemented in some
cases. However, if at all, they are done in a non-standardized
manner, and patients other than those we did the calculations for
may undergo the preventive measure (e.g. progesterone injection for
twin pregnancies instead of single pregnancies). This influences the
results in two directions. First, the incremental programme costs
(compared with no preventive measure) may in fact be lower
because the interventions have already been carried out on some
patients. Similarly, in those cases where appropriate patients have
already been treated in the appropriate way, the health effects in
terms of preterm births prevented may also be lower in real life.
This will, however, be balanced by those cases where inappropriate
patients are treated (e.g. progesterone injections for women with any
type of preterm birth, instead of spontaneous preterm birth) or
the treatment is done in the wrong way (e.g. infection screening for
bacterial infections only).

Furthermore, the effectiveness of the programmes with respect to
preterm births prevented is largely based on systematic reviews of
international clinical trials. Due to their limited external validity,
the effect of the programmes may be lower in a ‘real-world screening
programme’ and the transferability to the Austrian setting may be
limited. Yet, because of the high costs of premature birth and the
comparably ‘low’ costs of the screening programmes, the potential
savings very likely outweigh the costs in most of the programmes
analysed. Further analyses should take combined approaches that
may have the potential to further reduce the number of preterm
births into account.

Finally, as the overview of systematic reviews on measures to
prevent preterm birth shows, there are further approaches showing
promising effects on preterm births which merit consideration for
a budget impact analysis in future. Not least, some novel
interests. However, they have not undergone rigorous effectiveness evaluation so far. Furthermore, because we focussed on the prevention of spontaneous preterm birth, we restricted the analysis to preterm births <34 weeks of gestation, when most of the spontaneous preterm births occur in Austria. Future studies will have to pay attention to measures that take into account preterm births up to 37 weeks of gestation including provider-initiated preterm births.

In conclusion, our results are robust concerning the overall
positive economic net effect, suggesting the affordability of all the
programmes analysed in Austria. Because of similar trends
concerning preterm birth and the generally high costs of preterm
births, comparable results can be expected for other European
countries. In addition, the programmes have demonstrated a high
potential to reduce hospital cost burden, which is a priority in many
healthcare systems. Compared with other healthcare technologies
often showing much less favourable results, the implementation of
such a programme should be considered, with cervix screening and
infection screening being the most promising in candidates in
Austria.

Supplementary data
Supplementary data are available at EURPUB online.

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Key points

1. Preterm birth has become a growing public health issue all over Europe.
2. Several preventive measures are promising in terms of effective
cness and cost-effectiveness evidence.
3. If implemented for the appropriate target groups in Austria, a
number of preventive programmes show higher potential
cost savings than programme costs.
4. Prevention of preterm birth seems affordable and short-term
benefits can be expected for a selected number of prevention
programmes.
5. The general conclusion likely applies to other European
countries with a similar healthcare system structure and service provision level.

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Budget Impact Analysis of Outreach Services and Measures to Reduce Premature Birth.
Manganese concentrations in maternal and umbilical cord blood: related to birth size and environmental factors

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Background: Manganese (Mn) is an essential element and a potential toxicant for developing organism. Deficiency and excess of it were both deleterious to fetal growth in experimental animals. However, literature on relationship between Mn status and birth outcome in humans is sparse. Methods: Mn concentrations were measured in mother whole blood (MBW) and umbilical cord blood (UCB) in 125 pairs of mother–infant; birth size was examined and relationship between them was analysed. Potentially environmental factors influencing Mn loads in maternal and fetal organisms were investigated through epidemiological method. Results: Mn level in UCB was significantly higher than that in MBW (mean value: 54.98 vs. 78.75 μg/L), and a significant positive correlation was shown between them. There was a quadratic curvilinear (inverted U-shaped curve) relationship between MBW Mn and birth size, and between UCB Mn and birth size. Both univariate analysis and multiple linear regression analysis showed that exposure to harmful occupational factors during gestation remarkably increased maternal and fetal Mn levels. Living close to major transportation routes (<500 m) also increased the MBW Mn levels. Exposure to harmful occupational factors during gestation remarkably increased maternal and fetal Mn levels. Living close to major transportation routes (<500 m) also increased the MBW Mn levels. Conclusion: Our results suggested that lower or higher Mn level in maternal and umbilical blood may induce adverse effect on birth size in humans. In addition, increased levels of Mn in MBW or UCB may be associated with exposure to some environmental hazard factors.

Introduction

Manganese (Mn) is an essential nutrient for humans and animals.1 The daily intake of Mn through diet is an essential source to maintain Mn at an adequate dosage in human body. Mn participates in normal amino acid, lipid, protein and carbohydrate metabolism,2,3 and plays an important role in skeletal system development, energy metabolism, nervous and immunological system function, regulation of cellular energy, bone and connective tissue growth and blood clotting.1,4 Deficiency of it can result in dermatitis, slowing growth of hair and nails, decreases in serum cholesterol levels and clotting protein levels.4 Some patients with