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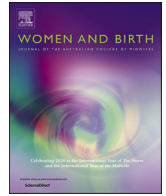
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Economic evaluation and budget impact analysis of midwifery-led care for low-risk pregnancies in Portugal

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ABSTRACT

Background: Midwifery-led models of care for low-risk pregnancies are associated with improved outcomes for mothers and babies, without additional adverse effects. These models are also considered more cost-effective than doctor-led or shared-care approaches.

Problem: In Portugal, midwifery-led antenatal care is not widely implemented, and its economic impact remains unexplored.

Aim: To estimate the cost implications of implementing a midwifery-led antenatal care model for low-risk pregnancies in Portugal, compared to standard doctor-led care, from the perspective of the Portuguese National Health Service.

Methods: A decision-tree model was developed to simulate the antenatal period through birth, comparing midwifery-led and doctor-led care. The eligible population included low-risk pregnant women. Outcomes included preterm birth, spontaneous vaginal birth, instrumental birth, and caesarean section. A budget impact analysis estimated the financial implications for the national health service. Sensitivity and scenario analyses tested the robustness of findings by varying key parameters and assumptions.

Findings: Midwifery-led care was estimated to cost €23.08 million, compared to €39.35 million for doctor-led care, resulting in projected savings of €16.27 million. Lower rates of preterm birth, instrumental deliveries, and caesarean sections, alongside increased spontaneous vaginal births, accounted for €10.07 million in cost-offsets. Total savings were estimated at €26.34 million, or €340 per pregnancy/birth, representing a 25.8% reduction in maternity-related expenditure.

Discussion and conclusion: Midwifery-led care presents a promising, cost-saving alternative to the current standard of care in Portugal, with the potential to improve clinical outcomes and optimize resource use.

Further research is needed to evaluate long-term economic and health impacts beyond birth.

Statement of Significance

Problem or Issue

Despite strong evidence supporting midwifery-led care for low-risk pregnancies, implementation remains limited in many

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health systems, including Portugal's.

What is Already Known

Midwifery-led models are associated with improved maternal and neonatal outcomes and are often cost-effective compared to doctor-led care.

What This Paper Adds

This study provides the first economic modelling of midwifery-led antenatal care in Portugal. It demonstrates that such a model could reduce national maternity care costs by over 25 % while improving clinical outcomes, offering compelling evidence for health policy change.

Background

Antenatal care plays an important role in saving lives, influencing the health of children, families and societies [1]. It is a complex care package that aims to educate women and families, promote healthy behaviours, detect conditions or threats to the mother or foetus, identify and support social, emotional and psychological needs at this critical time of life, supporting a positive life experience [2,3].

Countries vary in their antenatal care models. In 2016, the World Health Organisation (WHO) released recommendations to improve antenatal care utilisation and quality [1] and recommended midwife-led continuity of care models for women with low-risk pregnancies, in which a known midwife or a small group is the lead professional supporting a woman throughout the maternity continuum, and midwifery care in collaboration with medical professionals according to clinical needs for women with risk factors in settings with well-functioning midwifery programmes. The model underpins a philosophy of health promotion and the natural ability of women to experience pregnancy, labour and birth without routine invasive interventions. Building on this, the WHO's report, *Transitioning to Midwifery-Led Care Models* [4], further reinforces the importance of midwifery-led care, highlighting the need for structural reforms, workforce investments, and policy changes to facilitate the successful implementation and scaling of these models across diverse health systems.

This recommendation is supported by evidence, including three systematic reviews, amongst other high-quality studies, demonstrating that midwifery-led care and midwifery-led continuity of care [5–7] are associated with a range of benefits for mothers and babies and no identified adverse effects, when compared with doctor-led care or shared-care models. The most recent update of the Cochrane systematic review found that midwifery-led care was associated with higher chances of spontaneous vaginal birth and lower chances of instrumental births, caesarean sections and episiotomies [6]. The review also pointed to additional potential benefits such as greater likelihood of an intact perineum and breastfeeding initiation, and lower likelihood of a preterm birth, postpartum haemorrhage, induction of labour, low birth weight, or neonatal unit admission [6], though these were supported by lower-certainty evidence. Importantly, it highlighted the need for further research, particularly among low socioeconomic backgrounds. Complementing this, high-quality large population-based cohort studies have provided strong statistical power for some outcomes, including preterm birth, and consistently report lower risks of adverse maternal and neonatal outcomes among women receiving midwife-led care compared with doctor-led care. These studies confirm and extend the Cochrane findings, showing higher rates of vaginal births after caesarean, and breastfeeding initiation, alongside lower rates of premature birth, low birth weight, and low APGAR scores, amongst others [8].

Most high-income countries with universal health systems recommend midwifery-led care, with midwives also providing regular care for women with risk factors in collaboration with medical staff, except in

Portugal, where guidance on care leadership is lacking [9]. Portugal, known for its high intervention rates in pregnancy and childbirth [10] adopts a doctor-led model for the antenatal care of healthy women at low-risk of complications, despite having midwives trained to international standards and licensed by the Portuguese Nursing and Midwifery Council, who are specifically trained to care for and facilitate normal pregnancy and childbirth [11], alongside a critical 16.5 % [12] shortage of family-doctors for the overall population. The poor access of some citizens to care (including pregnant women) is not a new problem in Portugal, but it has deteriorated, most likely due to deficient health investment, inefficiency of the current model [13], and accentuated by the COVID-19 pandemic [14,15].

In the Portuguese National Health Service (NHS), maternity care is fragmented: low-risk pregnant women typically receive antenatal care from family health teams, composed of family physicians and general nurses, while obstetricians are mainly involved in the later stages of pregnancy and care of high-risk pregnancies. Midwives primarily provide antenatal classes, postpartum support, and other services in Community Care Units, but their autonomous role is limited by structural barriers. In hospital settings, they work alongside obstetricians, who lead the care. While some autonomous midwifery initiatives exist, they are exceptions to the norm. This fragmented system contributes to a lack of continuity and coordination. The private sector, heavily dominated by obstetricians, also plays a significant role, with a high proportion of births occurring in private hospitals. Caesarean section rates in these private settings can be extremely high, prompting concerns from the Ministry of Health. In contrast, private midwifery services, which are typically funded out-of-pocket, have also grown, providing the only access to midwifery-led care models throughout the maternity continuum, including home birth services.

Maternal mortality, in the absence of other quality indicators, is considered an important indicator of health system performance, and of effectiveness and quality of maternal care for high-income countries [16]. The most recent data reveals a rise in maternal mortality in Portugal since 2012 (12.8 per hundred thousand births), with the 2020 rate hitting the highest point since the 1980s (20.1 per hundred thousand births) [17]. This trend prompts concerns about the appropriateness of maternity care in Portugal.

Midwifery-led care has been discussed as a possible solution to address several of the above-mentioned concerns, at societal, professional and political level [13,18–20]. In some Portuguese regions this is not a novel solution. In the 1950s, midwifery care was introduced in Azores to reduce high maternal and infant mortality rates. This successful approach became standard. More recently, in Greater Lisbon, *Almada-Seixal, Lisboa-Occidental e Oeiras* developed programmes for caring for pregnant women without a family-doctor. These women are cared for by midwives, alongside a sporadic family doctor appointment supporting prescription of screening tests, which are mostly administratively restricted for midwives.

Adding to maternal and perinatal benefits, midwifery-led care is also found to be more sustainable and cost-effective in many high-income settings [21–23]. Evidence from other countries is, however, often insufficient for deciding on new healthcare implementations. Information on costs, impact on health outcomes and other resources is key to making informed decisions on whether a certain intervention is worth the investment of limited public money [24]. Economic evaluation, including cost-offset analysis, compares the costs and consequences of different interventions and is a key component in providing the needed evidence for sound decision-making [24].

This study specifically focuses on low-risk pregnancies and aims to conduct a cost-offsets and budget impact analysis of implementing midwifery-led care versus the current doctor-led model in the Portuguese National Health Service. The evaluation is undertaken from the health sector perspective and considers primary outcomes of spontaneous vaginal birth, caesarean section, instrumental birth, and preterm birth. These outcomes were selected for their relevance to health system

performance, cost implications, and alignment with existing evidence. The problem is framed as one of health rights, equitable access to comprehensive, systematic antenatal care and women's choice of care provider. While this study provides a comprehensive economic modelling based on aggregated national data, it acknowledges that population heterogeneity, particularly concerning socioeconomic factors, is a critical area for future investigation to ensure equity of care.

To the authors' knowledge, no studies have estimated the potential cost-offsets of midwifery-led care versus standard care in Portugal. Research is needed to evaluate this model's value for the Portuguese National Health Service and guide decisions on health service improvements.

Methods

Analytic approach

This study created a decision-analytic framework to compare the current doctor-led care approach for the care of low-risk pregnant women with an alternative midwifery-led care approach in the Portuguese context. Decision modelling is frequently used in healthcare to analyse complex problems, demonstrating that some interventions may not only be effective, but also cost-effective or otherwise, synthesizing information from different sources and quantifying costs and health outcomes of different alternative courses of action [25]. Costs and outcomes of both interventions were estimated over a clinical time horizon spanning pregnancy to birth, informing a one-year timeframe for the budget impact analysis that included potential cost-offsets from model implementation and monetized modes of care birth. In addition, we simulated a five-year phased implementation scenario.

The following principles underpinned the evaluation: (1) the adoption of a health sector perspective (that of the Portuguese National Health Service); (2) the time horizon of the analysis was the duration of the pregnancy until the time of birth; (3) data on the interventions was sourced from national perinatal data and/or best available evidence (4) costs are measured in € (EURO) 2022.

Interventions description

In Portugal, pregnant women are cared for by a "family health team", which consists of a family-doctor, a general nurse, and a clinical secretary. The care is provided in primary care centres, and the package of care consists of antenatal and postpartum consultations, as recommended by the General Directorate of Health antenatal care programme [26]. These consultations are generally two-step: first, the pregnant woman is seen by a general nurse, who makes a general assessment, then by the family doctor, who performs pregnancy screening and assessment. At term, the woman is either referred to her hospital of choice or geographical region [27] to have her last assessment by the hospital team. This includes at least one appointment with a midwife and one appointment with an obstetrician. Birth generally takes place at the hospital, and either a midwife or both a midwife and an obstetrician attend labour and birth. Following birth, and once discharged to primary care, the woman is again seen by the general nurse and the family doctor for at least one consultation in the first 42 days post-birth. In addition to this, the Portuguese National Health Service offers antenatal and postnatal classes/sessions provided by midwives.

In this study, we refer to standard care as doctor-led care model since it involves family doctor-led care for antenatal care and obstetric-led care once care is transferred to the hospital. Standard care is based on the official General Directorate of Health antenatal care programme. The alternative proposed midwifery-led care model is structurally identical to the standard doctor-led model in terms of consultation frequency and timing, but assumes a midwife is the lead care provider, who can also run health promotion sessions and provide intrapartum care. This model, based on the principles of midwifery continuity of care as

defined by the World Health Organization and other leading evidence-based guidelines, positions the midwife, "in partnership with the woman, [as] the lead professional with responsibility for assessment of her needs, planning her care, referral to other professionals as appropriate, and for ensuring provision of maternity services" [7], from initial booking to the postnatal period. Some care may be provided in consultation with doctors, as applicable, and women requiring additional care generally consult with different health professionals and are referred to obstetric-led care.

Although the scope of the maternity journey extends to the postnatal period, this evaluation's time horizon is limited to the costs and outcomes incurred from the duration of pregnancy until the time of birth.

Eligible population

This study modelled the delivery of antenatal midwife-led care compared to "standard care" (doctor-led) for low-risk pregnant women in the 2021 Portuguese population. Although there is no internationally agreed-upon definition, the National Institute for Health Care and Excellence (NICE) defines "uncomplicated pregnancy" (low-risk) as a singleton pregnancy where the mother is healthy and requires only routine antenatal care [28]. The researchers aimed to limit the extent of the model to low-risk pregnant women because that is the professional scope of both the family-doctor and midwives [29,30]. For this study, the total number of births in Portugal was used as a proxy for the number of eligible pregnant women, considering this to be the best available estimate. There is no available published data on the number of low-risk pregnant women in Portugal.

Model description

Model structure

A decision tree was implemented in Excel (see Figure A1 in appendix) to reflect possible 'pathways of outcomes' experienced by pregnant women as they progressed through pregnancy until birth. The model was used to estimate the potential implementation costs and costs related to modes of birth resulting from both "standard care" (doctor-led) and the "proposed" model of care (midwifery-led). The model simulated how a cohort of low-risk pregnant women transitioned between the states: pre-term or term birth, and mode of birth, namely spontaneous vaginal birth, instrumental birth or caesarean section.

A death state was not included since the number of births was used as a proxy for the number of pregnant women. Hence, it is known for a fact that these women reached birth; any mortality along the way was accounted for. Furthermore, maternal mortality in low-risk pregnancies is so low that the impact of eliminating the death state on the overall model was considered negligible.

Model parameters

Data for the model parameters were obtained from multiple sources. The effect estimates for the doctor-led care model were based on observed real-world data from the Portuguese National Institute for Statistics for 2021 (the Health Statistics Report 2021 [31], and the Demographic Statistics Report [32]). This provided data at the national level for women of reproductive age who gave birth to a singleton infant in Portugal between the 1st January and 31st of December 2021 (N = 77,450) and provided actual distributions of preterm births, spontaneous vaginal births, instrumental births and caesarean sections for the standard care model, which served as the baseline probabilities for our decision tree. The analysis was conducted using aggregated data, which precluded a detailed subgroup analysis due to missing information at the individual level (e.g., socioeconomic status, educational background). Consequently, the model's findings should be interpreted as an average for the low-risk pregnant population in Portugal and do

not account for potential variations in outcomes and costs across different patient sub-groups. For the midwifery-led care model, although a hybrid antenatal care model exists in parts of Lisbon, to our knowledge, no formal evaluation of its effectiveness or contextual factors has been published; therefore, no data from this programme were available to inform model parameters. In the absence of Portuguese outcome data, we used the structural care pathway based on the Portuguese General Directorate of Health's recommendations, and applied the relative effect sizes observed in a large retrospective cohort study (2008–2018) ($n = 425,056$) from British Columbia, Canada [8]. This study provided adjusted outcome probabilities for mode of birth and preterm birth stratified by risk level and lead care provider. We assumed that the effects of midwife-led care in that population would be transferable to a similar low-risk population in Portugal. This study was chosen for reference as having a comparable health system and providing up-to-date evidence for a low-risk population for midwife-led care.

Cost analysis

Intervention costs

Intervention costs were estimated from publicly available data and included both the costs of standard antenatal care for each arm.

The model used the minimum consultation frequency recommended by the General Directorate of Health, totalling seven visits [26]. It also included the average number of antenatal classes recommended [33], with 12 classes assumed from 24 to 28 weeks, at one per week. The cost of antenatal care in the doctor-led arm includes six consultations with a family-doctor, six with a family-nurse, one with an obstetrician, one with a hospital midwife/nurse, and a package of 12 antenatal classes. In the midwife-led arm, the cost includes seven consultations with a midwife and a package of 12 antenatal classes.

In this analysis, the term “implementation costs” is used in the economic evaluation sense, referring to the costs of delivering the model of care (i.e., provision of services) over the antenatal period. For the doctor-led care model, these costs are not additional or new expenses but represent the actual current costs incurred by the NHS for providing the existing standard antenatal care package. For the midwife-led care model, the same package of consultations and classes was costed, but with the relevant consultations provided by a midwife instead of a family doctor and general nurse, in line with the model definition. Unit costs were sourced from the last available government decree on regulations and price lists for the Portuguese National Health Service institutions and integrated services [34]: €16 per nursing/ midwifery consultation, €31 per medical consultation.

Costs of modes of birth

The following modes of birth (pregnancy outcomes) were monetised: preterm birth, spontaneous vaginal birth, instrumental birth, or caesarean section. The costs of these outcomes were based on diagnosis-related groups (DRGs) estimates. DRGs are patient classification systems consisting of classes of patients who are similar clinically and in terms of their consumption of hospital resources [35], and are used for hospital reimbursement by the state. The lowest severity rates were assumed, and the same prices were used for both family-doctor and midwifery outcome parameters.

For “Preterm Birth”, costs related to antenatal care up to 33–34 weeks gestation were included since the last available estimates of the premature population indicate that 89.4% of the premature births in Portugal occurred past 33 weeks gestation [36]. Similarly, for antenatal classes, it was assumed that these women and babies would attend one weekly class from 28 weeks up to 34 weeks, seven in total.

For the costs of instrumental birth, the DRG “Vaginal birth, with complex procedure excluding sterilization and/or dilation and/or

curettage in the operating room [*Parto vaginal, com procedimentos complicados, exceto esterilização e/ou dilatação e/ou curetagem em bloco operatório*] was used, since it described a complex birth (such as instrumental) and because there was no other classification that better described the procedure. Preterm birth, spontaneous vaginal birth and caesarean section have their own DRG codes. DRG code preterm birth is an additional cost to the births that happen before 37 weeks' gestation, regardless of mode of birth.

Table 1 outlines the parameters used to populate the model, as well as their sources and distributions used in uncertainty analyses.

Economic evaluation (cost-offsets) and budget impact analysis

The total expected costs of implementing each model (doctor-led and midwifery-led care) and the expected costs of different modes of birth were estimated to compare the potential cost savings between the two approaches, with all costs expressed in 2022 € (euros). A Budget Impact Analysis (BIA) was then conducted to assess the financial impact of midwifery-led care on the national health budget. In addition to the base-case annual estimates, the BIA included a five-year phased implementation scenario, beginning with 20% midwifery-led care adoption in Year 1 and increasing by 20 percentage points each year until achieving full (100%) implementation in Year 5.

Uncertainty and sensitivity analysis

The combined impact of uncertainty in the model's input parameters was investigated using a Probabilistic Sensitivity Analysis with a Monte Carlo simulation of 1000 iterations. The results of this analysis are reported with 95% uncertainty intervals, providing a comprehensive assessment of how parameter variability influences the model's outcomes. Additionally, we performed univariate deterministic sensitivity analyses to assess the separate impact of key input parameter assumptions. The separate impact of the following was modelled:

(1a and 1b) assuming a 39% and a 75% caesarean section rate for the premature population: the authors found two other literature references that assume different scenarios, one that further aggravates the impact of intervention and assumes a 75% caesarean rate in premature births [37], and one, on the opposite edge, alleviates the burden by assuming 39% caesarean rate. Neither was chosen for the model since the former is not from robust evidence, and the latter is from a retrospective study whose population included both late premature and early term babies.

(2a and 2b) assuming different resources needed within midwifery-led care, according to the guidance from the National Institute for Health and Care Excellence and the WHO: NICE Antenatal Care guidance [38] recommends a total of ten antenatal consultations for nulliparous women and seven for multiparous women. The number of consultations for nulliparous was assumed since being nulliparous is the case of the majority of the Portuguese pregnant women population [32]. The WHO (2016) antenatal care recommendations endorses a minimum of eight consultations throughout pregnancy. Both the WHO and NICE are internationally recognised for developing evidence-based standards for best practice. NICE develops guidance for England, a high-income country with healthcare organization and health financing comparable to Portugal. In the base case, seven consultations were assumed.

(3a and 3b) assuming other levels of severity when costing modes of birth (DRGs corresponding to moderate or severe). In the base case, DRGs corresponding to the lowest levels of severity were used to cost the different modes of birth, which, although a conservative approach, could underestimate the potential savings of implementing the midwife model of care. DRG for moderate complications of spontaneous vaginal birth is 646 €, for instrumental birth 1450 €, and caesarean section 2433 €. DRG for severe complications of spontaneous vaginal birth is 3050 €, for instrumental birth 7682 € and caesarean section 7271 €.

Table 1
Input parameters and uncertainty ranges (costs reported in 2022 €).

Parameters	Value	Uncertainty range	Distribution Used	Sources
Transition probabilities				
Doctor led care				
Live Term Births	0.925	NA	NA	Instituto Nacional de Estatística (2023b)
Live Term Spontaneous Vaginal Births	0.449	NA	NA	
Live Term Instrumental Births	0.180	NA	NA	
Live Term Caesarean sections	0.371	NA	NA	
Live pre-term births	0.075	NA	NA	
Live pre-term Spontaneous Vaginal Births	0.329	NA	NA	Botelho, T. (2003)
Live pre-term Instrumental Births	0.003	NA	NA	
Live pre-term Caesarean sections	0.667	NA	NA	
Midwife-led care				
Relative risk				
Pre-term Births	0.823	[0.769–0.881]	Log normal	Stoll et al. (2023)
Outcome probabilities				
Spontaneous Vaginal Births	0.872	NA	NA	Stoll et al. (2023)
Instrumental Births	0.056	NA	NA	
Caesarean sections	0.072	NA	NA	
Costs				
Intervention Costs				
<i>Consultation fees</i>				
Family doctor	31	(±20 %)	Triangular	Portaria n.º 254/2018 de 7 de Setembro Do Ministério Da Saúde, Article 15
Nurse	16	(±20 %)	Triangular	2018 Article 15
Midwife	16	(±20 %)	Triangular	Article 15
Obstetrician	31	(±20 %)	Triangular	Article 15
Antenatal Class	16	(±20 %)	Triangular	Article 15
Direct medical costs				
Pre-term Birth	662	(±20 %)	Triangular	DRG 563
Spontaneous Vaginal Births	593	(±20 %)	Triangular	DRG 560
Instrumental Birth	699	(±20 %)	Triangular	DRG 542
Caesarean Section	976	(±20 %)	Triangular	DRG 540
Total Intervention Costs				
	Doctor-led care		Midwife-led care	
Term birth				
Family doctor	6 × 31		0	
Nurse	6 × 16		0	
Midwife	1 × 16		7 × 16	
Obstetrician	1 × 31		0	
Antenatal Classes*	12 × 16		12 × 16	
Total cost	521		304	
Pre-term birth				
Family doctor	5 × 31		0	
Nurse	5 × 16		0	
Midwife	0		5 × 16	
Obstetrician	0		0	
Antenatal Classes*	7 × 16		7 × 16	
Total cost	347		192	

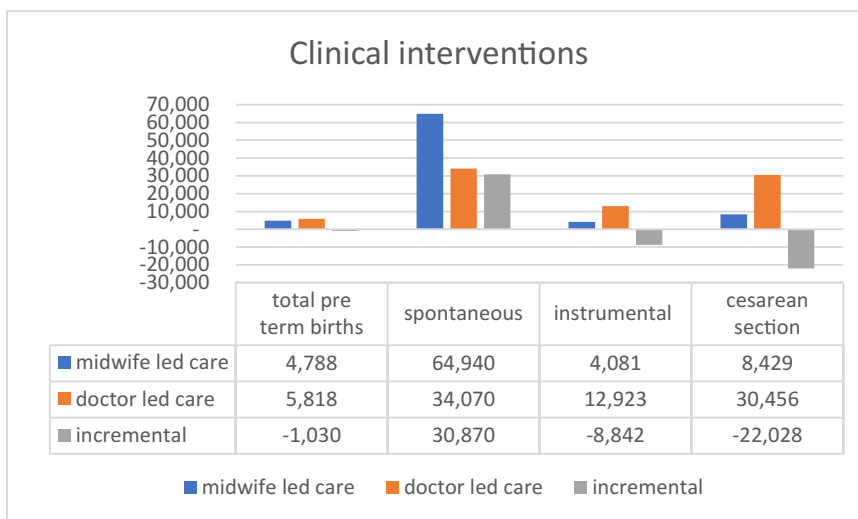


Fig. 1. Modes of birth in midwife and doctor-led care arms.

Table 2
Population-level cost estimates of implementation and modes of birth by model of care (in 2022 €).

	Midwife-led care Mean (95 % CI)	Doctor-led care Mean (95 % CI)	Difference (midwife-led vs. doctor-led) Mean (95 % CI)
Intervention/ implementation cost	€ 23,085,736 (20,474,788–25,775,000)	€ 39,359,330 (35,988,182–42,838,802)	€ 16,273,594 (19,030,168–13,427,793)
Modes of birth			
Spontaneous vaginal birth	€ 39,431,282 (33,571,268–45,114,693)	€ 21,407,620 (18,370,253–24,402,207)	€ 18,023,663 (15,222,534–20,745,667)
Instrumental birth	€ 2858,061 (2416,289–3298,111)	€ 9034,851 (7633,626–10,427,488)	€ 6176,790 (7134,285–5215,262)
Caesarean section	€ 10,322,750 (8911,203–11,739,024)	€ 32,240,699 (27,473,446–36,968,860)	€ - 21,917,949 (25,372,842–18,451,539)
Total cost related to the mode of birth	€ 52,612,093 (46,367,328–58,419,709)	€ 62,683,170 (56,567,839–68,575,153)	€ 10,071,077 (14,726,059–5449,113)
Total healthcare cost	€ 75,697,830 (69,127,682–82,152,539)	€ 102,042,500 (95,186,505–108,803,737)	€ 26,344,670 (31,400,162–21,109,550)

Table 3
Five-year cost projections (in 2022 €).

Year	Doctor-led Care Uptake	Midwifery-led Care Uptake	Implementation Costs Midwifery-led Care	Modes of Birth Outcome Costs Midwifery-led Care	Total Annual Costs Midwifery-led Care	Implementation costs Doctor-led Care	Mode of Birth Outcome Costs Doctor-led Care	Total Annual Costs Doctor-led Care	Annual Savings	Cumulative saving
0	100 %	0 %	€ 0	€ 0	€ 0	€ 39,359,330	€ 62,683,170	€ 102,042,500	€ 0	€ 0
1	80 %	20 %	€ 4617,147	€ 10,522,419	€ 15,139,566	€ 31,487,464	€ 50,146,536	€ 81,634,000	€ 5268,934	€ 5268,934
2	60 %	40 %	€ 9234,295	€ 21,044,837	€ 30,279,132	€ 23,615,598	€ 37,609,902	€ 61,225,500	€ 10,537,868	€ 15,806,802
3	40 %	60 %	€ 13,851,442	€ 31,567,256	€ 45,418,698	€ 15,743,732	€ 25,073,268	€ 40,817,000	€ 15,806,802	€ 26,344,671
4	20 %	80 %	€ 18,468,589	€ 42,089,675	€ 60,558,264	€ 7871,866	€ 12,536,634	€ 20,408,500	€ 21,075,736	€ 36,882,539
5	0 %	100 %	€ 23,085,736	€ 52,612,093	€ 75,697,830	€ 0	€ 0	€ 0	€ 26,344,670	€ 47,420,407

Results

Fig. 1 shows the distribution of modes of birth across the midwife and doctor-led care arms. Midwife-led care leads to fewer preterm births (n = 1030), instrumental births (n = 8842) and caesarean sections (n = 22,028) and to more spontaneous vaginal births (n = 30,870) compared to doctor-led care.

The costs of implementing the midwife-led care model were estimated at € 23.08 million compared to the implementation cost of the current doctor-led care, estimated at € 39.35 million (see Table 2). In the midwife-led arm, total cost related to modes of birth was estimated at € 52.61 million, corresponding to a total healthcare cost of € 75.69 million. Figures A2a and b (in appendix) depict the distribution of costs across the different modes of birth in each arm. Costs related to spontaneous vaginal births were the largest proportion of total cost, 52.1 %, in the midwife-led care model. In the doctor-led arm, total cost related to modes of birth were estimated at € 62.68 million, corresponding to a total healthcare cost of € 102.04 million. Costs related to implementation were the largest proportion of total cost, 38.6 %.

Implementation of a midwife-led care model would yield total healthcare savings of over € 26.3 million compared to the current doctor-led model of care, on a population level. The largest savings are related to the cost of antenatal care (€ 16.27 million), especially the use of less expensive healthcare resources. Costs related to the different modes of birth were responsible for over € 10.07 million in savings.

Table 4
Results from the univariate deterministic sensitivity analysis.

Analysis	Description	Midwife-led care	Doctor-led care	Savings (diff. midwife-led vs. doctor-led)	% change
Base case	Base case analysis	75,697,830 €	102,042,500 €	26,344,670 €	
1a	Assuming a 39 % caesarean section rate for the premature population	73,557,806 €	99,495,225 €	25,937,419 €	1.81 %
1b	Assuming a 75 % caesarean section rate for the premature population	76,382,197 €	102,927,049 €	26,544,852 €	0.52 %
2a	Assuming different resources needed within midwifery-led care - NICE	71,415,040 €	102,142,496 €	30,727,456 €	14.06 %
2b	Assuming different resources needed within midwifery-led care - WHO	68,631,689 €	102,142,496 €	33,510,807 €	21.20 %
3a	Assuming other levels of severity when costing modes of birth (DRG moderate)	94,546,805 €	158,032,988 €	63,486,184 €	58.41 %
3b	Assuming other levels of severity when costing modes of birth (DRG severe)	316,863,473 €	467,806,807 €	150,943,334 €	82.51 %

A BIA was performed to estimate the impact of midwifery-led care on the national health budget compared to the current model. Based on 77,450 pregnancies annually, midwifery-led care was projected to generate savings of € 26.34 million per year, equivalent to €340 per woman, and to reduce overall health expenditure for this population by approximately 25.8 %. In addition to the annual savings estimate, the BIA also modelled a five-year phased implementation scenario, starting with 20 % MLC adoption in Year 1 and increasing by 20 percentage points each year until full (100 %) implementation in Year 5 (Table 3). Under this scenario, Year 1 savings would total €5.3 million, rising to €26.34 million annually by Year 5. Cumulative savings over the five-year period were estimated at approximately €47 million.

Sensitivity analyses

The individual impact of different assumptions on the model results was explored (Table 4). Assuming different caesarean section rates for the premature population (scenario 1a and b) had little impact on the results. Results were also robust to changes in assumptions regarding the resources needed to implement midwifery-led care (scenario 2a and b). Assuming other levels of severity when costing modes of birth had the largest impact on results, with assuming modes of birth with moderate complications leading to three times larger savings (scenario 3a) and assuming modes of birth with severe complications leading to over five times larger savings (scenario 3b).

Discussion

This study estimated the potential cost-offsets and budget impact of implementing a midwifery-led versus the current doctor-led model for low-risk pregnancies in Portugal, over the antenatal period. The results show that, alongside other health outcomes reported in the literature, midwifery-led care in Portugal could have the potential to yield large savings, given the shift in the distribution of birth outcomes, including fewer preterm births, fewer instrumental births and fewer caesarean sections, which is consistent with the literature [23,39,40]. Experimental designs and retrospective cohort studies [21,23,41] also found greater value in midwifery-led care, and in consonance with Sandall and colleagues [6], the main drivers were related to reduced birth interventions associated with midwifery-led care, which resulted in reduced cost.

The results in this study are likely to be an underestimate of the gains of midwifery-led care in Portugal for several reasons. Short-term outcomes that were found to have an impact in other studies, including less likelihood to have an induction of labour, less likelihood of a postpartum haemorrhage, admission to the neonatal unit or having a low birth

weight baby (< 2500gr), less regional analgesia use, higher proportion of women who breastfeed exclusively, successful at a vaginal birth after caesarean section or that have an intact perineum [6,8,23] were not accounted for in this study. This was because of lack of data for the Portuguese population. The inclusion of these outcomes would have likely increased the potential savings of the midwife-led care model. Another example is the intervention costs for the premature births, a conservative approach was taken and no additional hospital visits or admissions for threatened preterm labour were included (since this is very individual and also because it was difficult cost it), however guidance on the management of these cases often includes hospital admission for clinical assessment, blood tests, corticosteroids, antibiotic and other drugs administration, additional fetal monitoring amongst others [42], all adding to cost. The same sub-estimation applies to the costs of spontaneous vaginal birth; by using DRGs, we assumed standard inpatient care costs for both models. However, this does not reflect reality as doctor-led births generally incur greater staff costs (involving both the attending midwife and obstetrician), whereas midwifery-led births typically involve only the attending midwife. Importantly, in doctor-led models, these additional professional costs are routine, applied universally, regardless of clinical need. In contrast, in midwifery-led models, the professional costs are more responsive to the individual's clinical condition, with medical involvement and its associated cost introduced only when complications arise.

Strengths and limitations

This study is the first to model the potential savings and budget impact of midwifery-led care in Portugal compared to standard care. This work was done using the best available evidence for the Portuguese context, both in terms of costs related to pregnancy and of mode of birth. Although not an exact portrait of reality but an approximation, sensitivity analyses were conducted to explore the impact of uncertainty in the model results. Throughout the study, the authors have taken a conservative stand to assumptions.

A key limitation of this study is the lack of usable individual data, which prevented subgroup analyses and filtering birth types by gestational age or risk status, requiring reliance on literature estimates and excluding any assumption of positive midwifery impact on premature mode of birth. Although microdata was granted by Shared Services for the Ministry of Health, the dataset was unusable due to extensive missing data. This constraint also hindered assessment of economic impacts across demographic groups, particularly low-socioeconomic status populations, underscoring the need for future research to collect detailed data to support equitable evaluations of midwifery-led care.

Another limitation is restricting this evaluation to the perspective of

the national health service. Assuming broader perspectives would allow taking account for health and economic impacts to other sectors of society, including impacts to the individual, their families, and society. Potential impacts could be gains in quality of life for women (lower morbidity) and other tangible benefits such as pregnancy and birth satisfaction, empowered transition to parenthood, better mother-child attachment and relationship, which in itself contributes to better outcomes in the longer [7,43,44].

Similarly, the time horizon only accounts for short-term health and economic gains related to the pregnancy period and does not account for longer-term impacts. Long-term costs are very complex to measure and to obtain data for. As an example, costs of greater levels of health problems in preterm babies throughout childhood, including child hospitalisation and infections, rates of educational attainment, costs for the family and society with absent labour days, transportation, and additional health costs, would certainly lead to larger economic gains for the midwifery-led compared to the doctor-led model [45]. As an example, a recent cross-sectional, observational epidemiologic study of premature births in Portugal reported significant morbidity, including invasive ventilation requirements in 43.5–71.2 % of the cases, sepsis incidence of 30.4–46.6 %, intraventricular haemorrhage in 22.9–40.1 % of the cases, retinopathy of prematurity incidence of 14.1–20.3 % amongst others [36].

The use of DRGs to cost maternity care is also not ideal since they address standard inpatient care and are limited in their capacity to determine and reflect actual money spent, possibly omitting important cost considerations [46]. The use of the lowest severity rates DRGs also automatically induced a sub-estimation of costs in general; however, since this was assumed in both doctor and midwifery-led care is unlikely to have caused a great impact.

Finally, this study did not evaluate the operational or workforce changes required for real-world implementation. Although midwives in Portugal are highly trained professionals whose education meets European standards, their current role in the public health system is constrained. Only the costs directly related to providing the model of care were considered; additional implementation requirements (e.g. knowledge updates for new roles) were beyond the scope of the analysis.

Implications for policy and practice

This study considers the potential short-term cost-offsets and budget impact of the implementation of antenatal care led by midwives in Portugal. The impact analysis further supported the model findings since results were also robust to changes in assumptions. The findings provide decision-makers with valuable information and a prediction of the economic viability of a project before its implementation, which supports important decisions concerning the allocation of public money in health services. The health benefits of midwifery-led care compared to doctor-led care are evidence-based and well known, but there is reluctance to change, possibly fed by both cultural factors and economic uncertainty. The results of this evaluation tackle the economic uncertainty and aim to support policymakers on the optimal allocation of resources in the care of low-risk pregnant women in the Portuguese context.

Conclusion

A midwifery-led care model holds promise as a good value for money alternative to the current standard of care in Portugal. It merits a deeper

examination of its long-term costs and benefits, particularly considering the well-documented health and economic ramifications associated with interventions and premature births.

Author s declarations

The manuscript is original work. All the authors have seen and approved the submitted version of the manuscript and agree to be accountable for all aspects of this work. The authors also declare that the article has not received prior publication, is not under consideration for publication elsewhere and abides by the copyright terms and conditions of Elsevier and the Australian College of Midwives

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Andreia S. Goncalves: Conceptualization, Methodology, Data curation, Formal analysis, Writing - Original draft preparation, Visualization. **Ana Paula Prata:** Conceptualization, Methodology, Formal analysis, Writing - Reviewing and Editing. **Christine McCourt:** Conceptualization, Validation, Writing - Reviewing and Editing, Supervision. **Richard Ssegonja:** Methodology, Validation, Formal analysis, Writing - Reviewing and Editing. **Filipa Sampaio:** Conceptualization, Methodology, Data curation, Formal analysis, Writing - Original draft preparation, Visualization, Supervision.

Ethical approval

Ethical approval was sought and granted by ICBAS, School of Medicine and Biomedical Sciences Ethical Committee (reference 2022/CE/P02/(P380/CETI/ICBAS).

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT (<https://chat.openai.com/>) in order to proof-read small sections of this manuscript. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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Declaration of Competing Interest

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