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What to expect, when you expect: the neurosurgical perspective

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Original Research

What to expect, when you expect. The neurosurgical perspective



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ABSTRACT

Background: Women in neurosurgery often have to delay pregnancy and child-rearing because the optimum time for having children overlap with an intense period of training and/or career advancement. The purpose of the study is to investigate the personal experiences of women neurosurgeons and understand the complex interaction between pursuing a career and embracing motherhood.

Methods: We employed anonymized, semi-structured interviews with women actively involved in the field of neurosurgery. Person-to-person interviews were performed online via video call. Responses were grouped and analyzed with thematic analysis. We identified recurring patterns and insights in the interview responses.

Results: We included twenty-one women neurosurgeons, at various career levels. Thematic analysis revealed diverse perspectives. More than half favored a delayed pregnancy announcement. The majority perceived a workplace, social stigma attached to pregnancy. Although most of them reported adequate support from their colleagues, several explained that the support was theoretical rather than practical. Many interviewees expressed their fears about losing their surgical skills, while 57.2% had concerns regarding their physical abilities during or after pregnancy. All but one felt that female neurosurgeons should not postpone or sacrifice motherhood for their career. However, alternative paths within neurosurgery could be an option.

Conclusions: Finding a way to combine a career in neurosurgery with pregnancy can be very challenging and may be vital to keep attracting quality professionals to the field. Efforts should be made to maintain the balance between career and home and to facilitate greater flexibility at the workplace for women who are pregnant and/or child-rearing.

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1. Introduction

Although female medical students have steadily increased and now outnumber male students in many countries around the globe [1] this shift has not significantly changed the male to female ratio in many surgical specialties [2]. Traditionally, surgery, including neurosurgery, remains male-dominated. However, the percentage of women entering into neurosurgery has been increasing over time [3,4]. To achieve a more balanced neurosurgical workforce, the goal for women should be to comprise 30 % of the profession's training grade by 2030 and 30 % of practicing neurosurgeons by 2038 [5]. In view of this, the possibility of pregnancy while training or practicing in neurosurgery needs to be explored and accommodated.

The impact of pursuing a career on pregnancy, childbearing, and childcare is well known. Family planning has become a priority for medical students in specialty selection [6]. In a recently published study, 43.4 % of medical students think that neurosurgeons' private life is adversely affected by their heavy workload [7]. Many female medical students, residents, and attendings still perceive that surgical specialties are incompatible with pregnancy and child-rearing [8,9]. Female surgeons are less likely to marry and have children compared to their men colleagues, and this difference is especially pronounced in neurosurgery [3,8–11]. In the US, the attrition rate for female neurosurgery residents is almost double that of men (18.5 % vs. 10.4 %, respectively) and women are more likely than men to switch specialties [12]. Similarly, the Gender Equality Committee of the Japan Neurosurgical Society reported that 17 % of women quit full-time employment as neurosurgeons. Difficulties in balancing neurosurgical career and motherhood and physical burden were the most common reasons [13].

It is well recognized that women surgeons who wish to have children face a difficult path due to pregnancy-related stigma, health concerns, brief maternity leaves, and a paucity of lactation and childcare support [14–20]. Women in neurosurgery usually face several challenges related to family planning and heavy workload [21]. Gupta et al. found that pregnancy and childcare play significant role to the recruitment, retention, and advancement of women in neurosurgery [22]. The most common experienced obstacles are insufficient time to care for newborns, discrimination by coworkers, and inadequate time to complete board requirements [22]. There is evidence that women in neurosurgery have more responsibilities at home, especially during the child-rearing years, which are demanding at home and at the same time crucial for a neurosurgeon's career [11]. However, the literature provides compelling examples of accomplished women in neurosurgery who have not only excelled in their careers but also achieved a balanced family life [23].

There are no guidelines or even widely accepted policies for pregnant neurosurgeons outlining the duration, the extent, and the conditions under which they should work but this is beyond the scope of this study. Our current study aims an effort to bridge knowledge gaps and address biases regarding pregnancy and child-rearing by following the experiences of female neurosurgeons who have already dealt with this situation. Our work suggests that motherhood may be compatible with pursuing a career in neurosurgery.

2. Methods

2.1. Research team / Reflexivity / procedures

Semi-structured, person-to-person video interviews were conducted by a female researcher (SM) having a background in qualitative methodology and a deep understanding of neurosurgery. The interviewer (SM) contributed neither to the invitation nor to the selection process of our participants. Objectivity was maintained by acknowledging the researcher's perspectives and potential influence on data interpretation. All interviewees were previously unknown to the interviewer. All participants were informed of the study aims. No suggestions of bias were

reported about the interviewer.

2.2. Study design

This study was underpinned by phenomenology, exploring how individuals perceive and express their experiences. Methodological orientation was chosen to deeply understand how female neurosurgeons balance pregnancy, motherhood, and career. In selecting participants, we looked for those who could provide descriptive, comprehensive information about their experiences. Participants varied in age, years of experience, and practice settings, providing a comprehensive overview of the subject matter. They were approached by email, with an invitation to participate and detailed information about the purpose of the study. Out of 30 individuals initially contacted, five refused to participate due to time constraints and four did not respond to the invitation. Finally, 21 women neurosurgeons, who were pregnant either during their residency or while practicing, participated in the study. Our participants, aged between 29 and 63 years old, presented with varying levels of experience and demographic backgrounds in order to capture a wide range of perspectives. No participants dropped out after agreeing to participate.

After pilot testing, the final version of the interview questionnaire guide was formed (Supplementary Material 1). We used a questionnaire to provide a detailed account of the challenges faced, the support received, and the decisions that were made by the participants during and after pregnancy. We also enquired about their advice and practical suggestions to others in the same situation. Semi-structured interviews offer a balance between structure and flexibility [24]. One-to-one interviews were performed by online videocall. Data were collected allowing participants to join from their preferred locations, such as their home or workplace [25]. Each participant was interviewed once; no repeat interviews were carried out. The interviews were carried out between the interviewer and interviewee only; the interviews were private and confidential.

A video recording of each interview was made using secure, encrypted software to ensure data security. Notes were kept during and after each interview to capture non-verbal cues and contextual details. The interviewer (SM) noted the responses in separate files. The duration of the interview ranged from 30 to 40 min, with a mean duration of 34.5 min. The responses were collected for statistical analysis. Data saturation was achieved when no new themes emerged. Transcripts were not returned to participants.

2.3. Data analysis

After reading the transcripts two authors (MK, CT) grouped the data thematically. Thematic analysis is a qualitative research methodology aimed at uncovering recurring patterns, and thematic elements within interview responses [26]. Thematic analysis was used in our study to identify recurring patterns and insights in the interview responses [26].

Participants' responses were organized into broad themes to provide a clearer understanding of their experiences. The purpose of our qualitative analysis was to capture the diversity of perspectives and identify similarities between participants.

Our study was confidential and anonymous. Informed consent was obtained from each participant. Each one was informed of the right to withdraw from the study at any time without consequences. No incentives were provided for participation. The analysis was performed using the R language [27]. Initial codes were created. Subsequently, these codes underwent a systematic process of categorization, and these were organized into broader themes to provide a better understanding of participants' experiences.

The primary objective of this analytical study is to encapsulate the diversity of perspectives inherent in participants' narratives, while concurrently identifying convergent themes. In the case of disagreement, the authors reached a consensus after consulting the senior author (AT). Finally, all authors reviewed the themes and collated the

associated outcomes. We did not consider participants’ feedback regarding study’s results.

2.4. COREQ Compliance

The COREQ checklist aims to improve the reporting criteria of qualitative research, mainly focusing on studies that use interviews and focus groups. It includes items tailored specifically for qualitative research, excluding general criteria applicable to all research forms. This checklist addresses crucial elements of study design that must be reported. Researchers can use the COREQ criteria to thoroughly detail important aspects such as research team, methods, context, findings, analysis, and interpretations [28]. This study strictly adhered to the COREQ guidelines to ensure comprehensive and transparent reporting. The completed COREQ checklist is provided in the [supplementary material](#) [Supplementary Material 2].

3. Results

Twenty-one female neurosurgeons at various career levels, practicing in nine countries, all members of the European Association of Neurosurgical Societies (EANS), were included in our study (Table 1). The mean age having the first child was 31.3 years (ranging from 27 to 41 years). Fifteen of the twenty-one women (71.4 %) were in training grade at that time. In majority of cases, our participants reported that they experienced one or two pregnancies Patterns, similarities and differences extracted from the collected data have been detailed and

Table 1
Our data in regards to pregnancy-related issues in neurosurgery.

General Demographics	
Number of interviewees	21
Countries of practicing	9 (Bulgaria, Cyprus, Germany, Greece, Hungary, Spain, The Netherlands, Türkiye-Istanbul, United Kingdom)
Mean age at first child	31.3 years
First child at residency	71.4 %
One pregnancy/interviewee	42.9 %
Two pregnancies/interviewee	28.6 %
Three pregnancies/interviewee	19 %
Four pregnancies/interviewee	9.5 %
Timing of announcement	
Early announcement	47.6 %
Delayed announcement	52.4 %
Supportive environment	
Adequate support from colleagues	57.1 %
Unfriendly environments	33.3 %
Pregnancy complications	
Preterm birth, miscarriage and/or intrauterine growth restriction	52.4 %
Elective abortions	9.5 %
Pregnancy-related complication rate	37.5 % (15 complications/40 pregnancies)
Family Planning	
Willingness to have more children	9.5 %
Postpartum Challenges	
Fears of losing surgical expertise	42.8 %
Concerns about childcare	19 %
Concerns about physical abilities (in the context of neurosurgical responsibilities)	62 %
Maternal leave & Return to Work	
Mean duration of leave	5.5 months
Challenges faced in returning to work	81 %
Professional performance after pregnancy	
Catch up on work between 1–2 years	23.8 %
Immediate return to work (<2 months)	42.8 %
Catch up on work between 3–6 months	33.4 %
Specialty change	
Attrition rate	4.8 %
Modifications in neurosurgery career paths	14.3 %

analyzed (Table 1).

3.1. Timing of pregnancy announcement

Approximately half of our participants (47.6 %) felt confident enough to announce their pregnancy as soon as they discovered they were pregnant. However, more than half of the interviewees (52.4 %) delayed their pregnancy announcement. This was related mostly to the stigma of pregnancy and the colleagues’ micro-aggressive behavior towards pregnancy (Table 2). One of our participants stated: “I felt a bit embarrassed when I got pregnant again so soon” (Participant 11), while another one affirmed: “Some young colleagues made it really tough for me, by yelling and saying things to make me feel very bad” (Participant 8). This finding shows the wide spectrum of colleague responses to female neurosurgeons sharing their pregnancy news with their colleagues.

3.2. Supportive environment during pregnancy

Twelve women (57.1 %) stated that they were adequately supported by their colleagues in dealing with the unique challenges posed by pregnancy. However, several women emphasized that the support was emotional rather than physical or practical. The main worry of interviewees was whether they would be treated as normal (Table 2). This was reflected in some of the following statements: “They consider you sick, so they behave like for a sick person” (Participant 18), “I was very concerned that my colleagues would not accept me as *one of them*” (Participant 19), “I was afraid of what the reaction of my colleagues would be” (Participant 8). One interviewee explained, in detail, how she was forced, while pregnant, to participate in an operation using fluoroscopy. Eventually, she left the operating room at the insistence of the anesthetist (Participant 10). This is a perfect illustration of an unfriendly or even malicious working environment which can be encountered by pregnant neurosurgeons.

3.3. Pregnancy complications

In our study we found a pregnancy-related complication rate of 37.5 % (15 complications per 40 pregnancies). Eleven out of 21 women reported preterm birth, miscarriage and/or intrauterine growth restriction. It is also worth mentioning that two out of 21 women (9.5 %) had elective abortions, because the pregnancy an unplanned. There were also several minor complications of pregnancy, such as vomiting, fainting, orthostatic hypotension, musculoskeletal disorders associated with poor posture in specific surgical procedures, etc., making the daily clinical practice quite challenging. One of our participants reported that she had to stay out of the operating theater for three months, because she was not able to stand, without fainting, for more than ten minutes, during the first trimester (Participant 1).

3.4. Family planning among women in neurosurgery

Of our cohort, a minority expressed a willingness to have more children (9.5 %). Only two interviewees indicated the desire to have more children in the future. This illustrates the conflict between professional commitments and family aspirations in the lives of young female neurosurgeons. Age, financial and social issues, career commitments and lack of time, as well as family planning were the main reasons for not wanting to have another baby (Table 2).

3.5. Postpartum challenges

Nine out of 21 participants (42.8 %) highlighted serious concerns about losing their surgical skills during or after pregnancy. In addition, approximately one fifth of the participants (19 %) shared serious concerns about childcare and the baby’s well-being. Thirteen interviewees clearly expressed apprehensions about their physical abilities at work.

Table 2
Concerns quoted from pregnant neurosurgeons.

Antepartum concerns
Whatever you do, there will always be factors against having a child (P ^a 9)
Fears about falling behind peers, missing out on job opportunities (P 16)
I was very worried about losing my position in the clinic (P 8)
Worried about deskilling (P 20)
I had fears for almost everything (P 8)
I was worried about my colleagues' behavior (P 21)
My colleagues would not accept me as "one of them" (P 19)
I was afraid of what the reaction of my colleagues would be (P 8)
Some consider you to be ill (P 4)
They don't really understand your feelings and fears (P 18)
They consider you sick (P 18)
Postpartum concerns
Concerns about return to work (P 1)
I was feeling guilty about my child (P 21)
Emotionally, I found return to work extremely difficult (P 17)
It is not easy to schedule and arrange everything while working hard (P 1)
It is hard emotionally, especially if I have promised to do something with my family after work, but...(P 8)
You are not "allowed" to make mistakes at work or at home (P 8)
There is almost no time for "me" anymore (P 19)

^a P, participant.

So, 62 % of the survey cohort voiced concerns related to standing for extended periods and managing demanding workloads during pregnancy (Table 2). The main problems were standing for long periods, heavy workload, nightshifts, vomiting, fainting and difficulties in surgical procedures, mostly spine cases, especially in the third trimester. Notably, one of the interviewees responded: “I was worried that I would not be able to follow-up with the patients I was caring for, during that time. I also had some concerns about being away from surgery, but I didn’t face any issues“ (Participant 11). Another response highlighted some of the additional challenges faced by pregnant neurosurgeons from their colleagues: “I was out of the operation theater for six months, as a punishment” (Participant 15).

3.6. Maternal leave

All participants of our study cohort chose to take maternity leave during and/or after pregnancy. The length of the maternal leave varied with an average duration of approximately 5.5 months (ranging from 2 months to 2 years). This variation in the length of leave varied depending on the relevant neurosurgical program and each country’s laws and regulations, but also on the individual woman’s preference, particularly when she had a shorter than average leave.

3.7. Return to work

Most interviewees (81 %) voiced challenges in returning to work. They emphasized the difficulty of balancing professional responsibilities and personal commitments. They found that “mom’s guilt” was the most common problem (Table 2). One interviewee remarked: “Getting back into the demanding schedule has been overwhelming; it’s a juggling act” (Participant 11). Based on the participants’ responses, women need to balance the time for care of their child, the fear of a challenging working environment and the limited personal time.

3.8. Professional performance after pregnancy

We found a remarkable diversity in the responses. Almost a quarter of our population (23.8 %) claimed that it takes one to two years to catch up to work, while 42.8 % declared that they felt ready to return to work immediately or in less than two months. The remainder (33.4 %) reported that the optimal time to return to work is between three to six months. One interviewee mentioned that after returning to work, her colleagues excluded her from the surgical lists, because she was out of the nightshift on call rota for six months. Therefore, her residency was

extended for one more year (seven instead of six years) (Participant 4).

3.9. Specialty change

Four individuals changed their mind about pursuing a career in neurosurgery. Some of them (14.3 %) reported a modification or change in their interests in neurosurgery and chose to pursue alternative paths, while others expressed positive or no influence. For example, one participant said: “I started performing fewer surgeries than before pregnancy. The reason is that the more cases I have, the more time I need to allocate to my patients outside of regular working hours. So, I reduced the number of surgeries I performed, which slowed down my pace” (Participant 11). Another one mentioned: “After having children, I fell behind in terms of academia” (Participant 19), while a third one noted: “After giving birth, I have less interest in cranial cases as they are more demanding” (Participant 12). Three months later, one of our interviewees left neurosurgery.

3.10. Advice based on lessons learned

All but one emphasized that women in neurosurgery should not postpone or sacrifice motherhood for their career. One participant warned that it will be tough (Participant 15), while several interviewees reported that it needs dedication, effort, work and a lot of passion in order to succeed. Two interviewees stated that it would be ideal to complete training before pregnancy (Participants 11 and 16), while another one mentioned: “Motherhood adds a different dimension to life. In a field like neurosurgery, filled with critical dimensions and gray areas, I always consider and interpret the experience of motherhood as an advantage” (Participant 12). These findings indicate that although work-life balance in neurosurgery is perplexing and challenging, pregnancy and child-rearing could be compatible with demanding fields, such as neurosurgery. Advice based on lessons learnt are summarized in Fig. 1.

4. Discussion

It is accepted that women in surgical fields face challenges regarding family planning [11,29,30]. Female surgeons often delay pregnancy and childbearing as the timing overlaps with training and/or career advancement [11,29,30]. It is also known that fertility declines with aging and this phenomenon is more common and occurs earlier in women [31]. The impact of pursuing a career on pregnancy, child-bearing, and childcare is well recognized. Many female surgeons,



Fig. 1. Advices of all participants of our study cohort based on lessons learned.

including women in neurosurgery, postpone pregnancy during residency or early career development. Perceived career threats account for the majority of gender-related delays to parenthood in neurosurgery [11,22,32,33]. A balance between professional challenges and personal aspirations seems to play a vital role. Moreover, a supportive environment is of paramount importance.

4.1. Discrimination and support

Although more women are entering the field of neurosurgery, discrimination against women in surgery is still prevalent, especially regarding pregnancy [34]. This stereotype seems to limit the implementation of preventive measures [34]. There is evidence that female surgeons also discourage other women from pursuing surgical careers [15]. Many women report stigma attached to pregnancy [20] and previous reports also indicate negative attitudes from colleagues toward pregnancy [19].

Seventy two percent of European women neurosurgeons express serious concerns for their career because of the negative impact of their desire to have children [35]. A study among vascular surgeons found that 21 % of women are afraid or anxious to share the news of their pregnancy with their colleagues [36]. Even female colleagues can hold negative views of pregnancy among their colleagues during training [19]. Microaggressions in the workplace mainly involving senior male residents and attending neurosurgeons is another issue [37].

In the US, many women surgeons feel poorly judged when pregnant and stressed to schedule their pregnancies during residency (73.1 %, and 55.1 %, respectively) [38]. Moreover, several women are worried about taking parental leave, as this would be detrimental to their careers [36].

Other factors with a negative impact include increased workload and the associated stress for their colleagues and economic hardship, in case of an unpaid leave [22,38].

In the US, the Accreditation Council for Graduate Medical Education (ACGME) recommends that all residents and fellows should take six weeks of paid leave, parental, caregiver, or medical, and should be entitled to the leave from the day they begin the program [39]. In Europe, although the maternity leave is paid, the payment represents 100 % of the wage only in 12 out of 32 countries. In the other European countries maternity pay varies with a range of 27–90 %. Many but not all European countries also support the parental leave which usually follows the maternity leave. This is either unpaid or very low-paid. There is only one European country, Lithuania, in which the parental leave is 100 % paid. For example, in the UK, the maternity leave is 30 % paid for 39 weeks, while the parental leave is not supported [33].

In our study more than half of our participants (52.4 %) favored announcing their pregnancy in a delayed fashion. Notably, one of them emphasized: "I should have announced my pregnancy earlier" (Participant 16), while another one stated: "My colleagues did not know about my pregnancy till the end" (Participant 15). This is a noteworthy aspect of the professional environment for women in neurosurgery. Characteristically, one of our participants noted: "Having a supportive community and mentorship is invaluable; it provides insights and encouragement during challenging times" (Participant 18). In our cohort 62 % emphasized the significance of seeking support and enjoying pregnancy.

Women experience more discrimination in the workplace and report more child-related barriers to their careers than men [11,40–42]. The stigmatization attached to pregnant women, seems to be related to the

increased workload of colleagues [43]. Men often believe that a pregnant woman is less capable to perform her job [36]. In many academic programs becoming a parent negatively affects female trainees' work performance and well-being compared to their male counterparts [20,44]. In Japan, 25 % of department directors state that they are reluctant to hire female neurosurgeons [10]. This attitude leads to a delay in pregnancy or forces women to work later during pregnancy [43].

In our study the mean age of having the first child was 31.3 years (ranging from 27 to 41 years) and a minority (9.5 %) expressed the desire for having more children. This shows the conflict between professional commitments and family planning decisions. According to the literature, professional priorities, financial concerns, spousal agreement, and personal challenges associated with childcare responsibilities were the most common reasons for not wanting more children [11,22,32,40–42]. Significantly more women than men delay having children [11,22,32,40–42]. Interestingly, one of our interviewees highlighted: "Having a child will never be convenient for the department. No reason to postpone, your male colleagues will be able to have family and you will not!" (Participant 14). This is understandable given the physical and/or emotional impact of pregnancy. Additionally, women also have reproductive age limitations to consider.

4.2. Pregnancy-related complications and fears

In the literature, complications of pregnancy among women in medicine are much higher than in the general population [43]. Additionally, female surgeons are at greater risk when compared to women in other medical specialties [45]. There is an increased risk of spontaneous abortion, preterm labor, and preterm delivery associated with night work [46,47]. As female doctors continue working while pregnant, work stress may negatively affect the outcome of their pregnancy [48,49]. A stressful working environment, sleep deprivation, long periods of standing, night-shifts, dehydration, exposure to several workplace hazards, and older maternal age are all factors associated with adverse outcomes in pregnancy [33,50–52]. According to our cohort, important problems faced during pregnancy were prolong standing, heavy workload, night-shifts, vomiting, fainting, radiation exposure and musculoskeletal disorders associated with poor posture in specific surgical procedures. Adverse outcomes, including pre-term birth, miscarriage, intrauterine growth restriction, and elective abortions were also reported, despite the small sample size of our study. The key is to maintain the balance between limiting the likelihood of pregnancy-related complications and respecting women's voluntary wish to continue with work and professional development.

On the other hand, pregnancy-associated fears and postpartum challenges, particularly when female neurosurgeons return back to work, are important. Concerns related to physical abilities during and after pregnancy, fears of losing their surgical skills and concerns about childcare, particularly the health of the baby were expressed in our study. A recently published study found that many surgeon mothers return to clinical duties early because of pressure from colleagues, financial concerns, and fear of prolonging training [53]. Insufficient time away from work during this period correlates with maternal depression, negative interactions with infants, low self-esteem, and strained marital relationships [54–56]. Also, the workload may have negative impact on their and/or their child's health (63.3 %) [38]. The desire for additional caregiving time is complicated by the competing concern of losing professional advancement opportunities. Indeed, many women have sincere concerns about pregnancy and child-rearing during training and wonder if this role is compatible with neurosurgery [57]. Our study is an effort to unravel this dilemma.

4.3. Experience-based advice

Our interviewees, based on their own experiences, emphasize the

importance of embracing motherhood alongside a neurosurgical career. In general, due to fear of falling behind their male colleagues or extension their training or even exclusion from surgery, female neurosurgeons often postpone their plans for pregnancy. This may also be related to the lack of a supportive environment. Knowing that, our participants emphasized the importance of encouraging female neurosurgeons not to sacrifice the opportunity to have children for their career advancement. They highlight that becoming a mother is one of the most beautiful experiences in a woman's life and advocate against sacrificing motherhood for professional achievements. The key is to maintain a harmonic balance between personal and professional aspirations.

According to the literature, American female surgeons in residency without children reported sadness when thinking about children ($p = 0.047$) and worry that they will never have children more than their men counterparts ($p < 0.0001$) [58]. Roberts et al. found that having children is crucial for the mental and physical health of health care workers [59]. The majority of our cohort reported that they would not do anything differently if they had to start all over again, with the exception of having a baby earlier and enjoy pregnancy more with less concerns. This advice reflects a collective perspective that values the multidimensionality of the lives of female surgeons and encourages maintaining a balance between pursuing a career and fully embracing the transformative experience of motherhood. Currently, this is a pivotal message considering the dramatically decreasing fertility rate worldwide [60].

4.4. Solutions and future perspectives

The need to re-evaluate policies and practices to ensure equity, transparency, and responsiveness to issues of discrimination in the workplace is of paramount importance [5]. Teaching hospitals and larger institutions should provide onsite childcare and encourage paid and gender-neutral family leave. Moreover, reduction of in-service hours, overnight or prolonged work, especially in the third and for symptomatic women in the first trimester, should inform practice.

Barriers to a stress-free pregnancy included a reduction in work/academic experience and progression of pregnant residents and inflexibility of attending/senior surgeons. Having female staff mentors who offer personal advice about how to balance pregnancy and/or motherhood, as well as the career's demands, is extremely important.

Flexibility under certain circumstances such as third and where applicable first trimesters, complicated pregnancy, assisted reproductive treatment, etc. and referral to mental health resources when needed, could be helpful for overcoming many pregnancy-associated difficulties. The development of guidelines for pregnant neurosurgeons is of paramount importance.

Social factors that vary between countries and different cultures, could also play a significant role in the acceptance of pregnancy in the neurosurgical workplace. Awareness and recognition of this problem firstly inside the neurosurgical community could be the first step. This could trigger a broad and sincere discussion of the problem, the establishment and support of neurosurgical committees responsible for this task and the collaboration with the government in order to align new policies with the law.

4.5. Study limitations

There are several potential limitations to our study. Firstly, the total number of participants is relatively small. Several female neurosurgeons who experienced difficulties, disliked discussing the conflicts of work and personal life. In addition, those who are busier may not have enough time to participate in this study. Our results are derived from experience and personal opinions, based on what we were told. Uncertainties or minor inconsistencies are unavoidable. All questions, including adverse events related to pregnancy and work-family balance, were reported by the individual experiencing the issues. Therefore, our results are a

unilateral representation of events which we cannot corroborate.

Other limitations include the potential for responders' bias, as well as the fact that the interviews were available only in the English language. In addition, the study focuses on the experience of participants from different countries with socio-economic and culture diversity. The timing the experience varied among participants, some having given birth very recently and other two decades ago. Nevertheless, our purpose is to initiate a thorough and sincere conversation about an issue, which equally worries both genders, although it seems to be an exclusively female problem.

5. Conclusions

With an increasing percentage of women working in neurosurgery, a changing surgical culture to support pregnancy is required. Now more than ever, we must face the fears of pregnancy-related complications and involuntary childlessness because of delayed attempts at childbearing. Having female staff mentors and changing practices to support pregnant neurosurgeons is hugely important. Although re-evaluation of policies and practices is crucial, policy alone will not lead to cultural changes. The key is to maintain the balance between mitigating the well-known "motherhood penalty" and respecting women's wish to continue with work and professional development. The value of the study is to bridge knowledge gaps and address biases regarding pregnancy in pursuing a career in neurosurgery. It is well-described that socio-economic, cultural and religious factors play a significant role in the difficulties of balancing a career in neurosurgery and motherhood. To our knowledge this is the first study to provide a descriptive, qualitative, personal experience of women training or practicing in different European countries on pregnancy-related difficulties that might interfere with their career in neurosurgery.

6. Ethical standard

This study does not contain any studies with human participants performed by any of the authors.

CRediT authorship contribution statement

Maria Karagianni: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Stiliana Mihaylova:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Christos Tzerefos:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Insa K. Janssen:** Writing – review & editing, Writing – original draft, Methodology. **Eleni Tsianaka:** Writing – review & editing, Writing – original draft, Methodology. **Mary Murphy:** Writing – review & editing, Writing – original draft, Methodology. **Nurperi Gazioglu:** Writing – review & editing, Writing – original draft, Methodology. **Marika L.D. Broekman:** Writing – review & editing, Writing – original draft, Methodology. **Niina Salokorpi:** Writing – review & editing, Writing – original draft, Methodology. **Maria Karampouga:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Ana Rodríguez-Hernández:** Writing – review & editing, Writing – original draft, Methodology. **Xanthoula Lambrianou:** Writing – review & editing, Writing – original draft, Methodology. **Ayşegül Esen Aydın:** Writing – review & editing, Writing – original draft, Methodology. **Silvia Hernandez-Duran:** Writing – review & editing, Writing – original draft, Methodology. **Daniela L. Ivan:** Writing – review & editing, Writing – original draft, Methodology. **Anastasia Tasiou:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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