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Analysing patient-generated data to understand behaviours and characteristics of women with epilepsy of childbearing years: A prospective cohort study

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ABSTRACT

Background: Women with epilepsy (WWE) are vulnerable in pregnancy, with increased risks to mother and baby including teratogenic risks, especially from valproate. The free EpSMon mobile-phone app allows self-monitoring to afford patient-centred feedback on seizure related risks, such as sudden death in epilepsy (SUDEP) to its users. We sought to generate insights into various seizure related risks and its treatments in WWE of childbearing age (16 to 60 years) using EpSMon.

Methods: The study utilizes a prospective real-world cohort of 5.5 years. Patient reported data on demographics, medication taken, diagnoses, seizure types and recognised biological, psychological, and social factors of seizure related harm were extracted. Data was stratified according to frequent and infrequent users and those scoring lower and higher risk scores. Multivariate logistic regression and different statistical tests were conducted.

Findings: Data from 2158 WWE of childbearing age encompassing 4016 self-assessments were analysed. Overall risk awareness was 25.3% for pregnancy and 54.1% for SUDEP. Frequent users were more aware of pregnancy risks but not of SUDEP. Repeated EpSMon use increased SUDEP awareness but not pregnancy risks. Valproate was used by 11% of WWE, ranging from 6.5% of younger to 31.5% of older women.

Conclusions: The awareness to risks to pregnancy, SUDEP and valproate is low. Valproate is being used by a significant minority. It is imperative risk communication continues for WWE based on their individual situation and need. This is unlikely to be delivered by current clinical models. Digital solutions hold promise but require work done to raise implementation and acceptability.

1. Introduction

1.1. Epilepsy and pregnancy

Approximately 40% of all women with epilepsy (WWE) are of childbearing age and WWE account for 0.5% of all pregnancies [1,2]. Consequently, epilepsy is often considered as the most common neurological disorder requiring medical treatment during pregnancy [1,3,4].

In the United Kingdom, approximately 2500 WWE give birth every year and in the US there are 24,000 births to WWE [5]. Whilst most

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WWE have an uncomplicated pregnancy, a significant minority face several unique challenges and concerns [3].

It is recognised that 9.7 women per 100,000 die during pregnancy or up to six weeks after childbirth or the end of pregnancy of whom 13% are a result of epilepsy or stroke [3]. Epilepsy and Stroke are the second most frequent cause of indirect maternal deaths in the UK [3]. In 2016–2018 a mortality rate of 0.91 per 100,000 maternities (95% CI 0.57–1.38) to epilepsy related causes was noted as compared to 0.52 per 100,000 maternities (95% CI 0.28–0.8) in 2013–2015 [3]. This is an increased relative risk of 1.75 (95% CI 0.84–3.79, $p = 0.1082$) [3]. Similarly, there is more than doubling of mortality regards SUDEP between 2013 and 2015 and 2016–2018 (RR 2.33, 95% 0.96–6.19, $p = 0.04$) [3].

Despite an increase in the number of treatment options available, pregnancy in WWE can pose significant maternal and foetal risks including spontaneous miscarriage, postpartum haemorrhage, preterm labour and major congenital malformations [4,5]. Most maternal and foetal risks occur within the first 8–10 weeks of pregnancy [1-3,5]. Certain anti-seizure medications (ASMs), especially sodium valproate (VPA) also have adverse impacts, especially in the first trimester [6].

Approximately 10% of women will have babies born with physical abnormalities if on VPA through the pregnancy as compared to 2 to 3% in general population. Of the 10% children with physical abnormalities, it is estimated 30 to 40% will also have co-morbid intellectual disabilities [6]. Similar concerns exist with other commonly used ASMs such as Phenytoin (6%), phenobarbitone (6–7%), carbamazepine and topiramate (4–5%). For most ASMs the risk remains poorly identified.

1.2. Epilepsy and maternal mortality

The risk of maternal mortality for WWE is ten times higher than the general population making epilepsy an important and common cause of maternal death in WWE in the UK [3,6]. Many maternal deaths in WWE are due to Sudden Unexpected Death in Epilepsy (SUDEP) [3,7]. SUDEP is often associated with poor seizure control arising from medication non-adherence and/or inappropriate ASM provision. It is estimated that approximately 40% of women stop taking their ASMs pre-conceptually or during pregnancy, due to concerns that ASMs may affect their baby's health [4,8]. In the UK the national confidential enquiry into maternal deaths highlighted that over a quarter of women were not taking any medication [3],

Unplanned pregnancies further increase concerns in relation to changes in seizure frequency and SUDEP risk including due to altered ASM metabolism and abrupt cessation of medication [8–10]. Women and general health practitioners may also be unfamiliar with the teratogenic risks of ASMs and their interactions with certain forms of contraception [4]. Many women are therefore unable to make a properly informed decision about their care and treatment [4].

1.3. Risk communication in WWE

In the majority of maternal deaths reviewed in the UK, ASMs seem not to have been optimised before, during or after pregnancy [11]. The high risk status of WWE during pregnancy and after childbirth is often not recognised by healthcare providers and this is highlighted as a contributing factor to epilepsy-related maternal deaths [9]. Over thirty percent of WWE report that pregnancy and contraception were never discussed [12]. Such findings are concerning as acknowledged risks, including maternal deaths, could potentially be minimized by early prepartum counselling, specialist input and support [9]. Prepartum counselling should therefore start no later than the first ASM prescription to a woman of childbearing age [9].

The extent, however, of any ASM related discussions in WWE of childbearing age is currently unknown, as is how many women avail themselves of such a discussion and change their lifestyles accordingly to mitigate epilepsy or ASM related harm for potential pregnancies.

This study explores levels of awareness in women of childbearing age about ASMs, SUDEP and pregnancy related matters using anonymised patient self-generated data collected from the *Epilepsy Self-Monitoring (EpSMon) mobile phone* app which is freely available in the UK (Appendix A). In addition, our study interrogates patient generated data to identify risk and outcomes and better understand how WWE are using digital technology to acquaint themselves with their wellbeing in the context of seizures. Finally, we seek to explore the strengths and weaknesses of such a digital self-empowerment tool to influence and inform future epilepsy care and safety.

2. Methods

2.1. Data collection tool

Relevant details of EpSMon are provided in Appendix A

2.2. Study recruitment, population and data collection

EpSMon was launched nationally in 2015 as a non-commercial product to inform safety for people with epilepsy. It was made available to all people with epilepsy in the UK for free. Thus, it could be argued that this study used an exponential and non-discriminatory snowballing technique for recruitment. This involved initially engaging with key contacts in professional, media and charity organisations and their respective social networks to regularly promote the availability of the app. This can therefore be considered non-probability sampling.

In this study, we extracted data from all women aged 16–60 years who have registered on the app. The lower limit of 16 was chosen as this is the cutoff for paediatric services in the United Kingdom. As the app has been validated for use in those above 16 it needs the person registering to be an adult. Although 95% of women are post-menopausal by the age of 55 years, this study covered a period of five years and so the upper age boundary was increased to 60 years to ensure those who were 55 at the beginning of the study period were suitably captured. No other exclusions were applied.

A focus group of people with epilepsy by social media invite and mailing list had been brought together after two years of launch to discuss the facilitators and barriers for adoption and retention of the App to help provide insights to the version 2 build in future. This included people who regularly use the App, those who had tried but not retained it and those who did not use it. The group of users highlighted that those who perceived themselves to be "low risk" in the first assessment or not notice any major change on "two assessments" tended to stop using the App. Based on this "frequent" and "infrequent" app users were defined. The "frequent" users were defined as those who accessed the app more than three times. The rest were defined infrequent users.

The app calculates a total risk score based on answers to the questions. The higher the total risk score of the assessment, the greater the risk of harm present for the respondent [13]. The maximum total risk score for an assessment is 32. All those above the 75th percentile for total risk score (score $\geq$ 18.5)) were placed into the High-Risk Group (HRG) and those with a total risk score $\leq$ 18.5 were placed in the Low-Risk Group (LRG).

2.3. Data analysis

Descriptive statistics and different statistical tests were used to analyse all risk factors. Multivariate logistic regression analyses were used to examine the associations between medication changes and assessment risk scores in the women. Odds ratios (ORs), 95% confidence intervals (CIs) and p-values for the associations between medications and assessment risks were calculated. Medications with fewer than three users were removed, because no efficient ORs could be generated for them. Logistic regressions to evaluate the associations between

medication changes and risk awareness of pregnancy in frequent to infrequent users was conducted. ANOVA was used to assess the SUDEP or pregnancy awareness risks in the women across different age groups. The Pearson's Chi-square test was used to assess the association between SUDEP/ pregnancy risk awareness and user type. The one-proportion Z-test was used to assess whether or not the responses in one group can represent the true proportion from the entire population. All analyses were performed using R 3.6.3 and relevant packages.

The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist for cohort studies has been used to guide the study reporting.

2.4. Ethics and governance –

EpSMon has been independently assessed and passed for data security and governance by the Organisation for the Review of Care and Health Applications (ORCHA https://appfinder.orcha.co.uk/). People using the app can choose to give consent to their data being used anonymously for research and service improvement. As per the NHS Health Research Authority tool (http://www.hra-decisiontools.org.uk/research/index.html) no formal ethical approval was necessary for this study. No patient identifiable data were used. Individual patient data were combined into a single dataset prior to analysis.

3. Results

3.1. Study sample

Of the total 4270 participants, there were 2606 women with epilepsy. Of these, there were 2158 females aged 16–60 years used the EpSMon app between October 2015 to April 2021. These users performed a total of 4016 assessments in the app. The data analysis is based on the total number of assessments, except when stated otherwise.

3.2. Characteristics of EpSMon users in the study population

Fig. 1 depicts self-reported seizure types of the studied population with onset-based age range. The most active group of app users in the study cohort was women aged 21–40 years. Generalised bilateral tonic clonic seizures are the most reported seizure type accounting for 37.04% of the total, followed by absence seizures (21.45%), and focal seizures (15.72%).

Frequent users formed 28% of the study cohort with a similar proportion across all age groups. Psychological illness was the most prevalent with anxiety, depression or psychosis reported in over 25.13% of all WWE under 60 years old. Asthma was the most frequent single physical health co-morbidity reported in 7.13%. No statistically significant differences were noted the comparison of various co-morbidities between frequent and infrequent users.

3.3. Awareness of SUDEP in women of childbearing age using EpSMon

Fig. 2 shows the SUDEP awareness as reported by women at all assessments across the age ranges. There was a statistically significant decline in awareness with age (p value <0.01). Below the age of 50 most women were aware of SUDEP (p value <0.01), although significant numbers reported not being aware. Over the age of 50 more women were unaware than aware. Fig. 3 depicts SUDEP awareness in frequent and infrequent users. Awareness of SUDEP between the two groups does not show statistically significant difference (53.43% and 54.95% respectively).

3.4. Awareness of pregnancy risks in women of childbearing age using EpSMon

Fig. 4 shows the risk awareness from epilepsy during pregnancy across different age groups. In 74.7% (3000/4016) of assessments, the users reported being unaware of pregnancy risks of epilepsy and/or ASMs. There was reducing awareness with increasing age (p <0.01). Fig. 5 depicts the awareness of pregnancy risk in frequent users against infrequent users. Pregnancy awareness and user type had a statistically significant association (p value<0.01) with frequent users being more aware, however the ratio of being aware of pregnancy risk in infrequent users was higher than the ratio in frequent users.

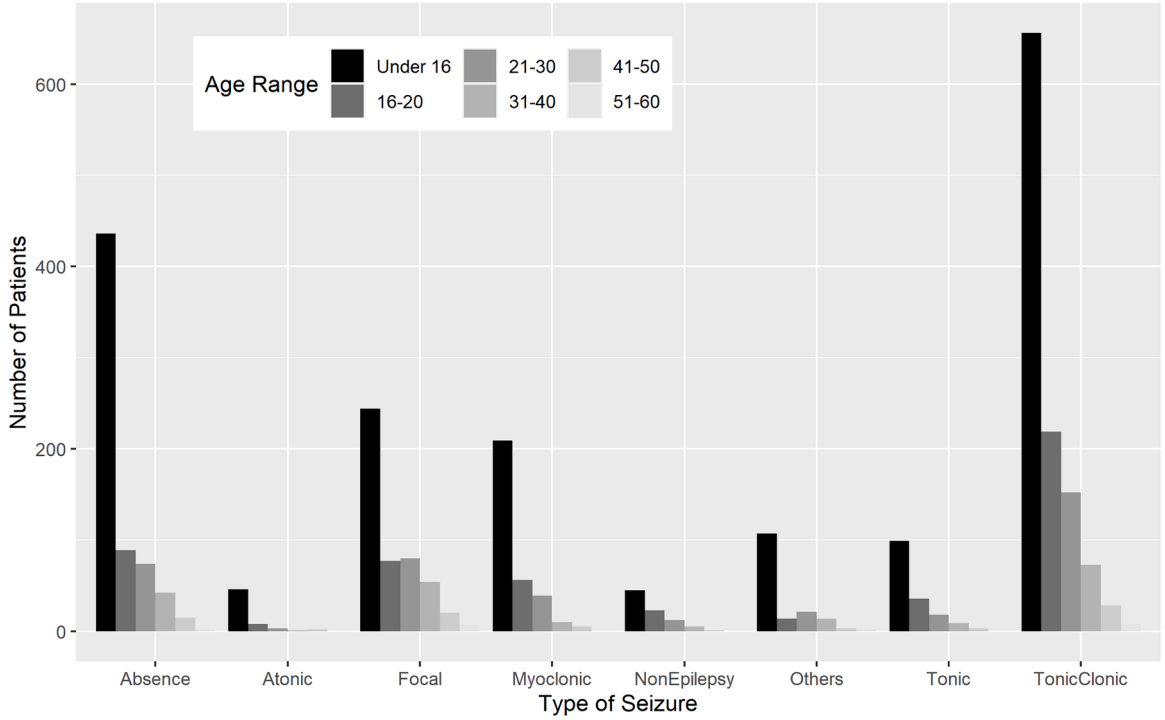

Fig. 1. self-reported seizure types with onset-based age range.

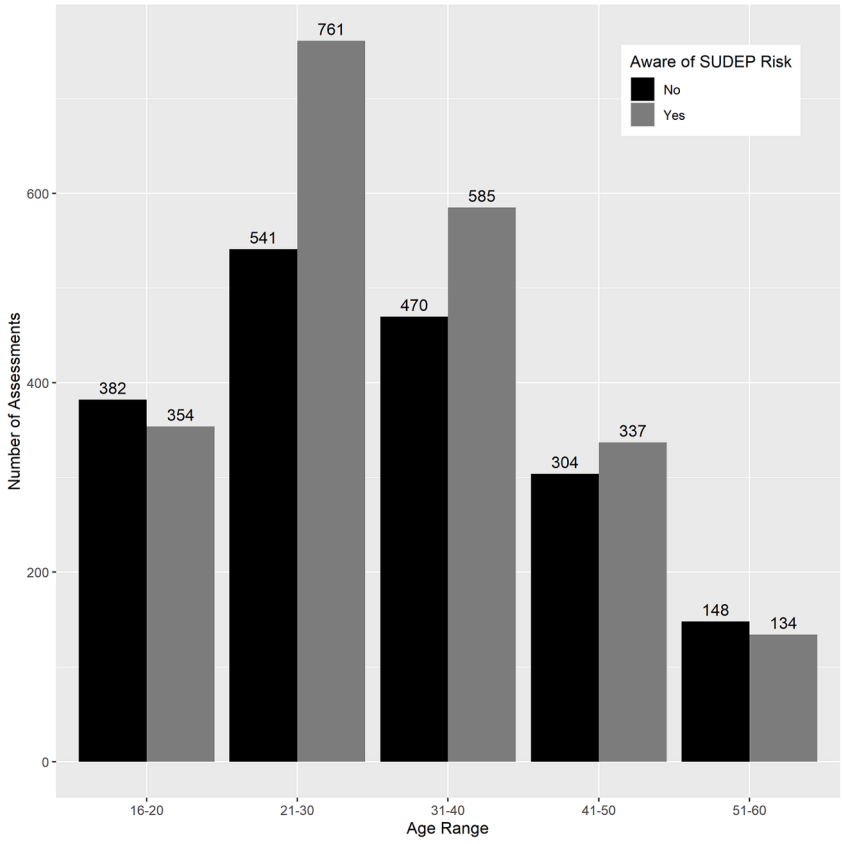

Fig. 2. Reported SUDEP awareness.

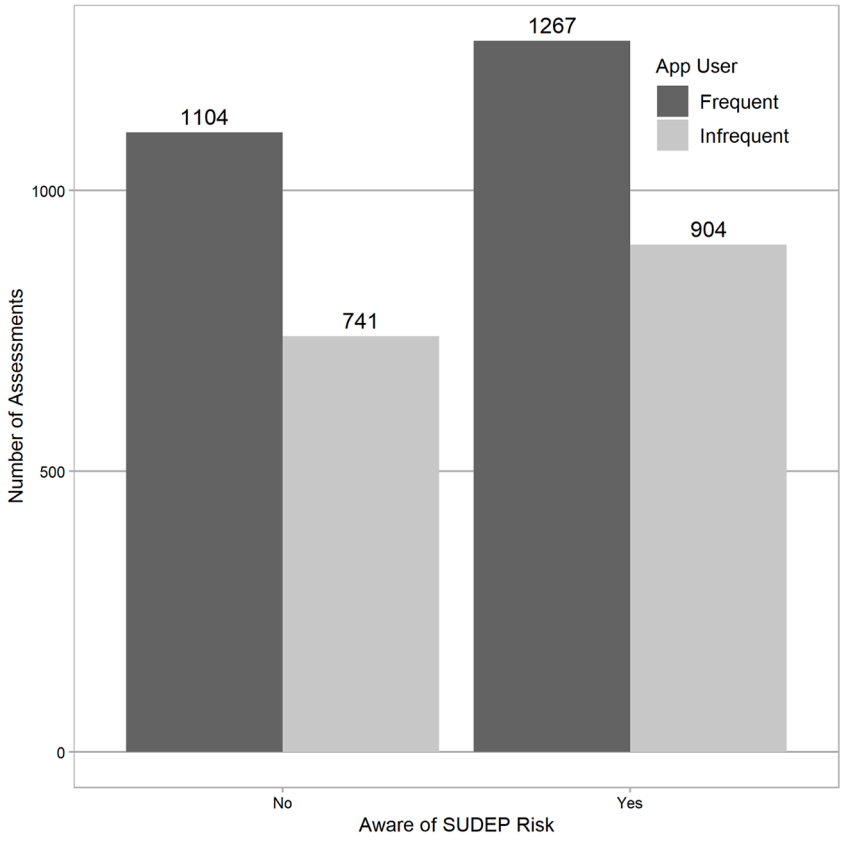

Fig. 3. SUDEP awareness in frequent and infrequent users.

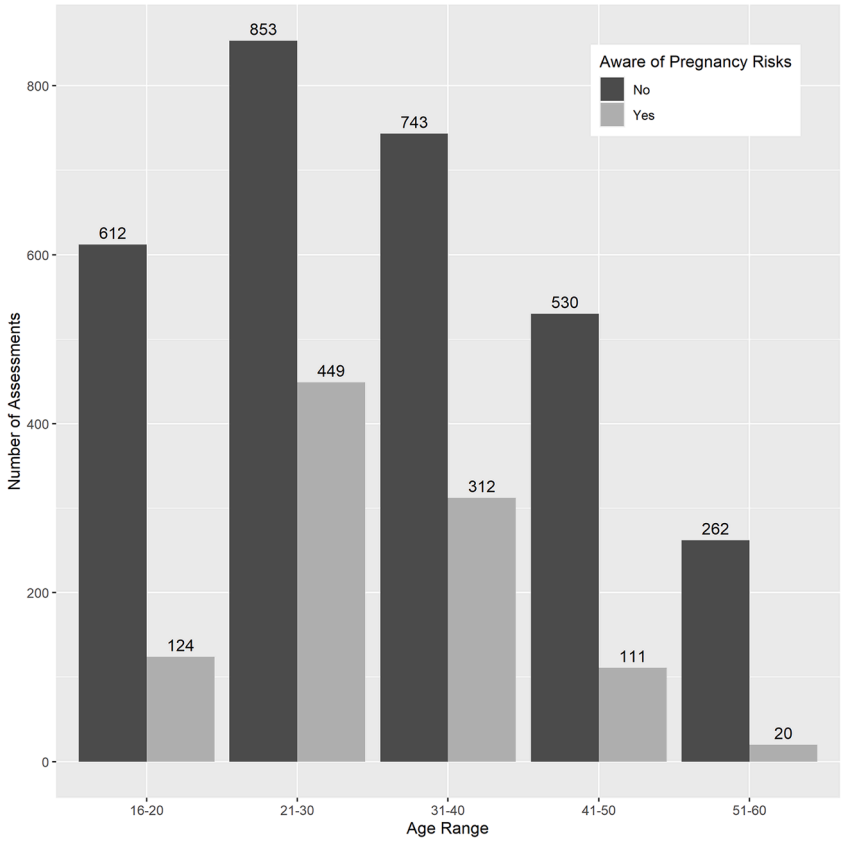

Fig. 4. risk awareness from epilepsy during pregnancy across different age groups.

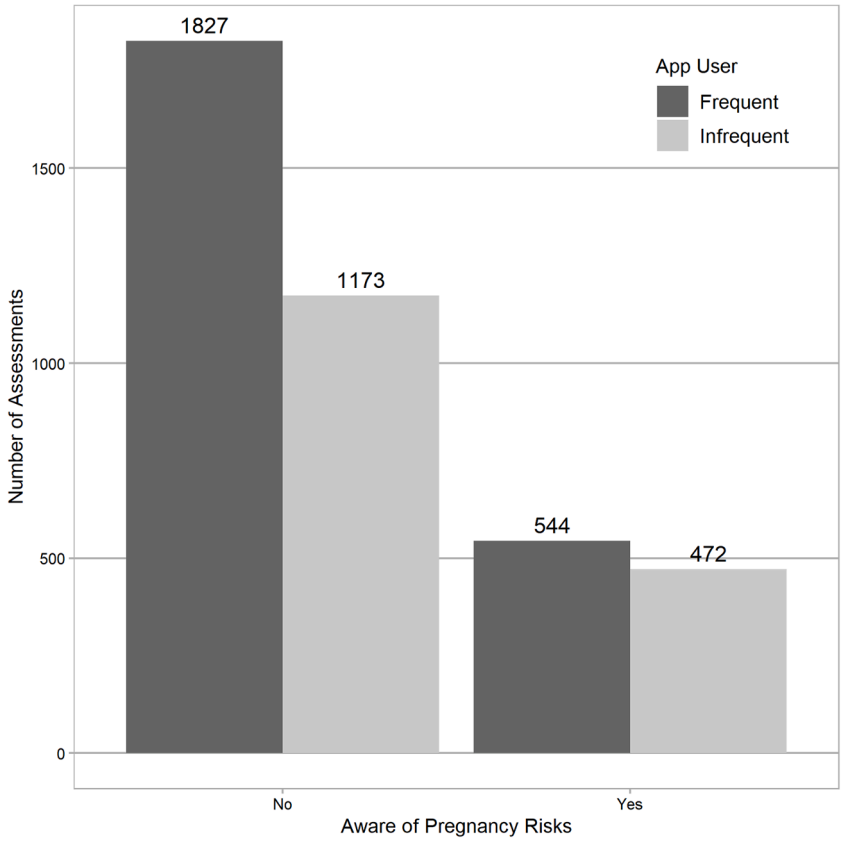

Fig. 5. awareness of pregnancy risk in frequent users against infrequent users.

3.5. The types and frequencies of ASMs, including VPA use, in women of childbearing age

Amongst the studied participants, a total of 22 different ASMs were administered. The average number of ASMs prescribed per participant across the 5 years was 3.08 (SD 6.70). The most prescribed ASMs were levetiracetam (n = 1521) and lamotrigine (n = 1494). VPA use was recorded in 428 (11%) of assessments in women of childbearing age, with a lower rate in 51–60 (6.5%) and a higher rate in 31–40 (31.5%). Supplementary information 1 illustrates the medication usage of frequent and infrequent users of the app. In both frequent and infrequent groups, lack of awareness of VPA risks was similar.

Of the 22 ASMs used by the study cohort the probability analysis showed that seven ASMs (carbamazepine, clobazam, clonazepam, lamotrigine, levetiracetam, perampanel, topiramate) were more likely to be used by the High-Risk Group ($p < 0.05$). VPA use was not significant indicating lower usage by the High-Risk Group.

3.6. SUDEP awareness change in frequent users

Supplementary information 2 shows the awareness of SUDEP by frequent users in relation to the number of assessments, comparing the last result with baseline. There was no obvious difference in the proportion of patients demonstrating SUDEP awareness when app was used for the first three times (59.53%, 61.37%, 60.36%). In the 4th assessment, the proportion with awareness dropped to 54.84. However, the sample size for the 4th assessment (n = 186) was 31% of the original cohort.

3.7. Pregnancy awareness change in frequent users

Supplementary information 3 shows the risk awareness in pregnancy by frequent users in relation to the number of assessments comparing the last result to baseline. Baseline awareness was 28.26% which was then noted to fall steadily in future assessments.

3.8. Cumulative risk factors- total risk score

The total average risk of the 32 factors assessed in each assessment of EpSMon was calculated. Fig. 6 captures the distribution of number of risks by age. The distribution of risks between frequent and infrequent users was compared in supplementary information 4. The average risk for a person using EpSMon per assessment was 8.87. Those who were frequent users had an average risk score of 8.35 per assessment and infrequent users had 9.64 per assessment. There was a statistically significant difference in scores between frequent and infrequent users (p value <<0.01). In the study population, the risk scale 4 received the most assessments (409), and those in the age group of 16~20 accounted for 58.92% amongst the women with total risk scale 4. Across all risk scales, the age group of 21–30 was the most active accounting for 32.42% of total assessments, following the age group of 31–40 accounting for 26.27% of total assessments.

4. Discussion

Patient self-generated data via mobile equipment or home care monitors are important resources that supplement existing clinical data and help generate a more comprehensive picture of patient health [14, 15]. Such data provide information on an ongoing basis, rather than at a single time point as happens in the traditional medical encounter. Patient-generated data can therefore be very useful for preventative care management of chronic conditions [16]. Importantly, gathering information on medications via patient-generated data can improve patient safety [17]. Understanding changes in a patient's condition, symptoms or medications outside of the traditional medical encounter could act as an incentive for change in treatment approaches but has a poor evidence base in medicine in general and none in epilepsy [18,19].

The majority of women were infrequent users of the app with the most frequent users in the age group of 21–40. The increased usage in those aged 21–40 might reflect women of childbearing age feeling more at risk and wanting to use the app whilst the drop in use over 40 years may be due to digital exclusion. Tonic-clonic seizures were reported in more than a third of assessments. This is of some concern, as tonic-clonic seizures are associated with an increased risk of maternal and foetal

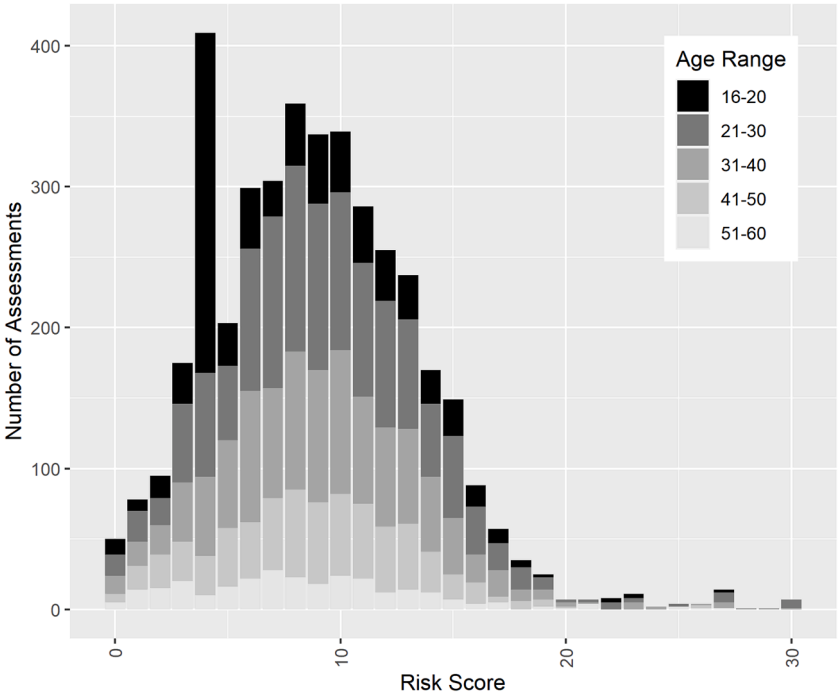

Fig. 6. distribution of number of risks by age.

problems and SUDEP.

The most prescribed medication was levetiracetam closely followed by lamotrigine, reflecting current advice over using low teratogenic risk medications in WWE of childbearing age. The third most prescribed medication was carbamazepine followed by clobazam. Concerningly, VPA takes fifth position with 11%, although slightly lower at 8% in the 21–30 group, suggesting that the message about avoiding commencing VPA in fertile women is possibly being successful. This might be due to increased awareness in prescribers, particularly neurologists [20]. The figure for the 41–50 age group of 16% is concerning. This study cannot determine if women taking VPA are part of the MHRA scheme for monitoring prescribing. However, the trends seen in this study are consistent with recent published evidence of those in primary care where there has been a reduction in prescribing of VPA but concerns about patient education and awareness [21].

There were significant associations between the frequency of app use and changes in prescribing of some of the ASMs. Frequent app users were possibly more likely to have their epilepsy reviewed thus prompting drug changes. Interestingly this did not apply to those women taking VPA, which suggests that there could be a degree of resistance to changing the drug but whether this is patient or physician led is not possible to ascertain.

Although most WWE app users of childbearing age are aware of SUDEP, there are still a significant minority who are unaware of such risk. Initial awareness of SUDEP was seen to be 53–55% consistent between frequent and infrequent users. Another recent single site UK study of repeat attendees to a specialist neurology clinic showed similar results i.e., 50% ($n = 50$) had SUDEP awareness [22]. A study from the USA which surveyed 1392 PWEs and 611 caregivers demonstrated higher levels of SUDEP awareness than found in our study and the other UK study [23]. Interestingly, internet respondents were much more likely to have heard about SUDEP than the clinic population (71.1% vs. 38.8%; $p < 0.001$) [23]. Caregivers of PWEs were more likely to have heard about SUDEP than PWEs (76.2% vs. 65.2%; $p < 0.001$) [23]. It could be a reflection on those who use the internet for such information are more likely to a greater interest in their condition. However, it does build the case to have evidence-based tools providing good quality risk information, such as EpSMon made available for those PWE and their carers who want to know more about their risks.

Awareness declines with age, with more than half of the women aged over 50 being unaware of SUDEP. There may be several reasons for this, including the drive amongst epilepsy professionals to improve awareness for newly diagnosed women but with less emphasis on revisiting this issue in those with well-established epilepsy [24]. Older users may feel less vulnerable given SUDEP is more common in the younger age range [25]. Nonetheless, it would have been hoped that all WWE would be fully informed. There was no obvious difference in awareness until at least the 4th assessment. This suggests that SUDEP risk communication needs to be repeated on multiple occasions and requires a degree of engagement from users. Current practice mandates informing people with epilepsy of SUDEP being led by clinicians [1]. Our finding suggests that to ensure effective communication, SUDEP related information needs to be provided on multiple occasions preferably tailored to the individual's situation [26]. The challenges of risk communication cannot be solely left to the clinician discretion or responsibility [27]. Digital technology may be a vehicle to achieve this. It is possible that the EpSMon app messaging needs to be more direct to improve SUDEP awareness.

It is both disappointing and alarming to note that an overwhelming number (75%) of the assessments for WWE in childbearing years report being unaware of the pregnancy related risks associated with seizures, including risks of generalised seizures and medication effects. This is at considerable divergence from another UK study ($n = 100$) where 55% of participants stated they were not involved in decision-making though that was specific to VPA related knowledge and not generic pregnancy related risk matters [28].

The app presently offers more in risk communication than accepted standard good practice, where discussion of pregnancy related risk issues is left to clinical judgement. Given that the app looks to reinforce risk communication at each assessment but appears to have failed to do so comprehensively suggests a deeper challenge than previously imagined. The fact that some WWE who engaged with the app failed to retain the pregnancy related risk information highlights the complexity of communication involved. It could be that the risk is not satisfactorily cognitively processed, retained or individualised by the user. Significant efforts have been made in recent years by epilepsy professionals, support groups and government health agencies to address pregnancy awareness and VPA issues. Education and communication must be accompanied by consideration as to how messages will reach all sectors of the target population and recalled satisfactorily [29].

4.1. Strengths and limitations

This is a prospective cohort study based on a large data set of more than 2100 WWE of childbearing age. The data record the users' own perceptions which is both a strength and weakness for this study. The data reflect the beliefs and understandings of individual people, and the real effect on their lives, giving credence to the conclusions drawn. There are, however, several limitations. We have derived many of our statistical analyses from the results of the total number of assessments, so a single individual may score more than once in any category. As these are at different time points, we feel this is a fairer reflection of the active problems being reported in this group. This mobile application has provided a data field from only one country which is an economically developed country with 92% of the population having access to a smartphone [30]. People who engage with the app may not be representative of WWE of childbearing age. Even so, if we consider this group to be more motivated to manage their epilepsy, the results are still of concern.

An important gap in knowledge for the App is the lack of any questions for current VPA users to self-identify if they are on the VPA Pregnancy Prevention Programme (PPP) or not. This is because the questions asked in EpSMon were originally created in 2015, prior to the PPP's introduction. While the app does include information about the risks of valproate, and the existence of the PPP within its education module, at present, it has not been possible to add additional questions to the app to address this gap. A process to create a new version of the app is due to start soon and will look to understand who is on the PPP. It would be important for the App's next version to also understand if VPA was the only medication able to stop the person's seizures and whether they had chosen VPA after informed discussion.

5. Conclusion

5.1. Implications for clinical practice

Patient generated data can provide significant insights into WWE of childbearing age. A concern is the presumption that risk communication sits with the clinician. As shown in our study it is the individual's awareness which matters. This is sadly lacking on key issues related to SUDEP, pregnancy and medication (including VPA).

5.2. Implications for policy

There are many sources of information available to WWE, but this analysis indicates that this information is not getting through to those at risk or may not be explicit enough about SUDEP and seizure safety risks to be understood and retained by WWE, and so should prompt a change in the way healthcare professionals interact with women and how governing bodies provide their safety information. There is a demonstrable change in behaviour by frequent users of the app, although there is a challenge in persuading many women with higher risks to use it more frequently.

5.3. Implications for technology development and patient engagement

EpSMon is the first prototype of its kind in epilepsy care globally. While results of its impact on changing risk by improving awareness are mixed it holds promise to the future. Educating patients via their smart devices with timely medical information improves their clinical outcomes and is cost effective [31]. Health apps can improve actual patient knowledge better than standard educational practices if users are offered information in a structured and targeted manner such as interactive medium (quizzes/video), daily or weekly reminders or thematic engagement [32]. Learning from these, newer versions of EpSMon need to consider a suitable design change with an informed co-production group. Other aspects include potential to use EpSMon to respond to risk and areas of need in a targeted and prompt manner [33]. There is potential to consider a MHRA 'Prevent' question as a drop down for anyone taking VPA in version 2 of EpSMon [6].

5.4. Implication for research

Our study opens opportunities for a plethora of diverse and intersectional research on a range of topics from patient decision making, patient education, patient generated heath data usage and analysis to targeted implementation of digital tools. The target population of WWE of childbearing years is a good templar to investigate challenges of chronicity, risk, impact of a health condition and its treatment on an individual's life.

Disclosure of potential conflicts of interest

SZ, ER and RB are supported by eHealth Productivity and Innovation in Cornwall and The Isles of Scilly (**EPIC**) grant funded by the European Regional Development Fund (RDF) to support small and medium business research development, which supported Psychoanalytica Ltd. for this study. RS and SUDEP Action are co-developers of the SUDEP and Seizure Checklist which has been converted to the digital app EpSMon. BMcL, SA, CN, PH and RS have been involved in the development and promotion of EpSMon. EpSMon is a non-commercial product owned by the SUDEP Action charity. SA works for SUDEP Action. EW, RL and RS are directors of Psychoanalytica which is a non-commercial social enterprise. Psychoanalytica has been given freedom to act from SUDEP Action for research initiatives of EpSMon. Psychoanalytica received research support for data analysis from EPIC. AS is supported by the Oxford NIHR Biomedical Research Centre. The Oxford Epilepsy Research Group, which AS leads, has received research monies from Bial, Eisai Europe, Livanova and UCB Pharma. BM has received institutional and research support from LivaNova, UCB, Eisai, Bial and Jazz pharma outside the submitted work. RS has received institutional and research support from LivaNova, UCB, Eisai, Veriton Pharma, Bial, Averelle and GW pharma outside the submitted work.

Author contributions

RS conceived this study. SZ conceived research methodology and led statistical analysis. ER conducted early data analysis. ER, SZ and RB drafted the manuscript. PH, CN and SA supported data collection. RS, BM, RL, AS, EW and SZ conducted revisions. AS, RW, EW and RL made substantial contribution to interpretation of the work. All authors give final approval of the manuscript, and all agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work is appropriately investigated and resolved.

Data statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.seizure.2023.04.008.

Appendix A: EpSMon

EpSMon is a free to download (Apple and Android) patient led mobile Smartphone App for people with epilepsy (PwE) to self-monitor risk of harm from epilepsy and associated factors (https://sudep.org/epilepsy-self-monitor; functionality demonstrated at: https://www.youtube.com/watch?*v*=Sz5BoejqdII&feature=emb_imp_woyt) [34]. EpSMon is derived from the SUDEP and Seizure Safety Checklist, which is validated for person centred communication of epilepsy and SUDEP risk [35–38] (https://sudep.org/checklist) and has been independently validated in 2021 by Organisation for the Review of Care and Health Applications (ORCHA https://orchahealth.com/) with a usability and acceptability score of 73% to an Evidence Standards Framework for Digital Health Technologies Tier 2b (now tier B) of the NICE evidence standards framework [39]. EpSMon is also recommended by the UK NHS Right Care epilepsy toolkit in 2020 [40].

The aim of EpSMon is to identify changes in a person's risk profile with three-monthly reminders to update what has occurred since the previous data entry. EpSMon then generates a rudimentary risk score and a range of recommendations including advice to book a review with a primary health care physician if there is an identified change in risk profile. Through a simple list EpSMon collects key characteristics including sex, ethnicity, details of all ASMs and psychotropic medication, their prescribed diagnoses and types of seizures. The app also asks binary questions on established risk factors for SUDEP and seizure safety including psychological/physical/social issues relating to sleep, alcohol, compliance, stress, and comorbidities including physical and mental health issues. Each response is allocated a risk score of 1 or 0 based on a particular risk factor's presence or absence. On completing the review, the users are informed if there has been a change in risk, the nature of that change, and, if necessary, to seek help from a healthcare professional to review whether any action may be needed.

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