

Article

Correct Use of Three-Point Seatbelt by Pregnant Occupants

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Abstract: The largest cause of accidental death and placental abruption in pregnancy is automobile collisions. Lives can be saved by correct use of the three-point seatbelt during pregnancy. Human interaction is essential for correct use of seatbelts. The objective of this study is to investigate pregnant women's use of correct shoulder section together with correct lap section as advised by obstetricians and highway experts and to identify the most common seatbelt misuse during pregnancy. An international web survey was conducted in five languages for this study. 1931 pregnant women reported their use of seatbelts and how they position the shoulder and lap sections of their seatbelts. Special attention was paid to distinguish between 'partly correct' and 'correct' seatbelt positioning. The questionnaire responses are used to determine the magnitude of every combination of the correct and incorrect shoulder and lap section of the seatbelt positioning during pregnancy. Results show that seatbelt usage in pregnancy is generally high in the world. However, the correct use of the entire seatbelt is very low, at only 4.3% of all respondents. 40.8% of the respondents use the shoulder portion of the belt correctly, whilst a 13.2% use the lap section correctly. The most common misuse is 'across abdomen' or 'not using the seatbelt at all', and both pose danger to pregnant women and their fetuses. Correct use of three point seatbelts is a challenge during pregnancy. We recommend that the media, medical community, and automotive industry provide targeted information about correct seatbelt use during pregnancy and accident databases include 'correct seatbelt use' information in crash statistics.

Keywords: seatbelts; passive safety; pregnant; belted; unbelted; occupant safety

1. Introduction

Each year there are 780,000 pregnancies in the UK alone, according the Office for National Statistics [1–3]. UNICEF estimates that at least 130 million babies are born each year worldwide [4], which means that at least as many pregnant women exist in the world every year. The study by Pearlman showed that the largest cause of accidental death, disability, and placental abruption in pregnancy is automobile collisions [5]. In order to reduce the incidence of trauma in pregnancy, it is important to protect pregnant women and fetuses during vehicle collisions, and safety restraint systems are therefore vital. Early crash test studies [6] have established the importance of seatbelt use during pregnancy, and that using a three-point seatbelt provides more effective protection than a lap belt.

Advice based on the definition of correct seatbelt positioning for pregnant occupants have been adopted by current governmental guidelines in the UK Department for Transport [7] and the National Highway Traffic Safety Administration in the USA [8].

Acar and van Lopik [9] have developed 38-week pregnant occupant model 'Expecting' with a fetus in uterus. The model has been used to simulate a range of scenarios (e.g., Acar and Esat, [10]) and has

shown that wearing the seatbelt correctly can play a critical role in the safety of the fetuses and pregnant women. Pregnancy can cause a wide range of size and shape changes that can affect women's use of seatbelt. A study by Johnson and Pring [11] investigated by a structured questionnaire how pregnant women were using their seatbelts in the UK. Out of the 159 pregnant women, 98% percent wore seatbelts in the front, 68% wore seatbelts in the back of a car, 48% correctly identified where to place the seatbelt, and 37% had received information on seatbelt use while pregnant. The study concludes that many pregnant women are not aware of the correct usage of seatbelts, their positioning, and legal requirements. In a study in Ireland, based on the assumption that seat belts are infrequently and often incorrectly utilised by women during pregnancy, Wallace [12] investigated General Practitioner's knowledge of and attitudes to the use of seat belts in pregnancy. Only 30% provide regular advice, and less than 50% indicated that they are aware of the correct advice to give. Ichikawa et al. In Japan [13] studied the seatbelt use exemption during pregnancy and concluded that misunderstanding of the benefits is one of the factors contributed to decline in seatbelt use during pregnancy. Studies from the USA [14–18] presented varying percentages of seatbelt use by pregnant women in some specific states of the USA. Further studies in the field [19–23] reported the provision of information about seatbelt use in pregnancy and recommend informing women about how to use the seatbelt during pregnancy.

National and international accident databases include pregnant crash statistics and seatbelt usage but do not include 'correct' use of seatbelts. Previous studies, describing the correct lap belt position as 'underneath the abdomen' did not clearly distinguish between the (incorrect) position 'lap belt across the upper thighs' and the correct position according to guidelines 'across the hips'. Similarly previous studies state that the shoulder belt should pass 'between the breasts' with no clear definition of how the shoulder belt should pass over the shoulder. Their 'correct' seatbelt positioning ratios in these studies therefore could easily include some responses from women where the shoulder belt is correctly positioned between the breasts, but at the same time incorrectly placed off the shoulder.

The aim of this study is, therefore, to establish the level of correctly/incorrectly positioned seatbelt use during pregnancy, focusing on correct use of the three-point seatbelt without any ambiguity. Differently from previous studies, correct use of shoulder and lap portion of the seatbelts were included together with the incorrect use as options in the questionnaire with the aid of illustrations, and the respondents were asked to report their personal way of wearing the seatbelt. Unlike previous studies, in this study we have clearly identified the 'correct' positioning of lap belt and shoulder belt during pregnancy and the most common seatbelt misuse as explained in detail in the Method section, below.

2. Method

This research is based on a questionnaire completed by 1931 pregnant women from around the world. The questionnaire was designed to identify pregnant women's habits and problems. This article focuses on the seatbelt usage and other habits during pregnancy are beyond its scope. The details of the questionnaire, sampling, and data collection were as follows:

The seatbelt related questions were designed first to investigate whether the pregnant women, as drivers or passengers, wear their three-point seatbelts or not, and if relevant, the reasons for not wearing them. We did not offer any information about the correct use of lap and shoulder belt prior to completing the questionnaire.

The advised correct position for the seatbelt during pregnancy as given by the UK Department for Transport [7] and the USA based National Highway Traffic Safety Administration [8] is:


For the shoulder section: passing between the breasts and around the abdomen,

For the lap section: across the hips underneath the abdomen.

The three-point seatbelts were designed to affix the body to the vehicle seat. Three-point seatbelts also help spread out the impact energy over the chest, pelvis, and shoulders. Questions S3 and S4 in Figure 1 were the only seatbelt positioning questions. These questions were carefully designed to


emphasise the definition of ‘correct’ use of shoulder belt and lap belt sections. Special attention was paid to differentiate the cases where the shoulder section of the seatbelt was correctly placed ‘between the breasts’ from the incorrectly positioned ‘off the shoulder’ and similarly to differentiate the cases where the lap section was correctly placed ‘underneath the abdomen’ from the incorrectly positioned ‘across the upper thighs’.

S3) How do you position the shoulder section of your seat belt over your chest? (Please choose the picture that best describes how you wear your belt across your chest for each car)




1 2

Across the top of the chest
above both breasts




1 2

Across one breast and
over the bump




1 2

Between the breasts and
around the bump



1 2


Off the shoulder and
around the bump



1 2


I don't wear the shoulder
section of the belt

S4) How do you position the lap belt over your abdomen? (Please choose the picture that best describes how you wear your belt over your abdomen for each car)




1 2

Across the top of
the thighs



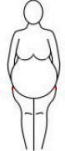
1 2

Across the hips
underneath the bump



1 2

Over the bump



1 2

I don't wear the lap
section of the belt

Figure 1. Questions 3 and 4 in the questionnaire showing seatbelt position options.

Likely seatbelt positions were included and graphical representations were supported by verbal descriptions. The questionnaire also included questions regarding safety concerns or discomfort in seatbelt use. Finally questions to investigate the pregnant women’s awareness of and access to available information on seatbelt use were also included.

The questionnaire was available on-line in five languages: English, Spanish, Turkish, Italian, and French. Each language version was prepared by native speakers of the language or professional translators from the European Languages Department of Loughborough University. A paper based version was also available on the website for those who prefer completing the printed version of the questionnaire but evidently no one used it. The approval of the ethical advisory committee of Loughborough University were sought and granted before the questionnaire was made available.

The questionnaire was advertised in pregnancy related forums. The only eligibility condition for the subjects was ‘being pregnant’.

At the time of analysis, 1931 sets of questionnaire responses had been received from all over the world, the majority from Europe. Responses were received from Algeria, Andorra, Anguilla, Antigua, Argentina, Australia, Austria, Barbados, Belgium, Bolivia, Botswana, Bulgaria, Cameroun, Canada, Chile, Colombia, Costa Rica, Cyprus, the Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Germany, Greece, Guatemala, Haiti, India, Indonesia, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kenya, Kuwait, Luxembourg, Madagascar, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Pakistan, Palestine, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Romania, Serbia and Montenegro, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Trinidad & Tobago, Tunisia, Turkey, UAE, Uganda, UK, USA, and Venezuela.

The aim is to investigate the level of misuse all over the world, regardless of the cultural backgrounds. Hence, responses from all countries were combined and the misuse types were identified. Throughout this paper, the pregnant women's data refers to this sample. The answers are also tabulated for three geographic regions—Europe, North America, and the 'Other Countries'—to have an idea about possible trends. The purpose is not to compare the three-point seatbelt usage of pregnant women from different part of the world as each of these groups, especially the Other Countries potentially represented massive cultural variations.

3. Results

3.1. Usage of Seatbelts During Pregnancy

In the combined sample, 1774 (91.9%) of 1931 of pregnant women report that they wear a seatbelt whilst they are pregnant. However, this does not mean that they wear the seatbelt correctly. The data reveals that 94.8%, 92.2%, and 83.3% wear seatbelts respectively in Europe, North America, and the Other Countries, as shown in Table 1. For those women who did not wear the seatbelt, the most common factors were 'comfort' and 'safety concerns'.

Table 1. Details of pregnant women and seatbelt usage rates by global region.

Region	Europe	North America	Other Countries	All
Number (n)	1236	258	437	1931
Seatbelt use number	1172	238	364	1774
Ratio	94.8%	92.2%	83.3%	91.9%
Mean gestation level (weeks)	26.4	27.5	23.4	25.9

Table 2 shows self-reported three-point seatbelt shoulder and lap sections use. 40.8% of pregnant women wear the shoulder belt in the correct position, and 13.2% wear the lap belt correctly across the hips. Overall, the correct shoulder section (CSS) proportion is significantly higher than the proportion of the correct lap section (CLS). Only 4.3% of pregnant women simultaneously use both the shoulder and lap sections correctly.

A large proportion of data received from European (64%) and from North American (12.3%) pregnant women. Hence, it is worth observing the seatbelt use in separate tables for those populations. Table 3 shows that 5.2% of European pregnant women simultaneously correctly use both the shoulder and lap sections. Almost one in two European pregnant women in this sample population position their shoulder belt correctly. However, almost one of six of them position the lap section correctly.

Table 4 reveals that the CSS proportion in North America is 43.8% and CLS proportion is 11.7%. Only 3.5% in North America position their entire seatbelt correctly.

The CSS proportion in the remaining countries of the sample is 27.2%, whereas the CLS rate is 11.4%, as shown in Table 5. In this group 2.3% use the seatbelt correctly as a whole. Also, 17.2% of pregnant women in this sample do not use any seatbelt.

Table 2. Seatbelt positioning numbers (and %) for pregnant women: Proportion of the ‘Correct use’ of three-point seatbelt is 4.3%. (✓ Correct seatbelt position).


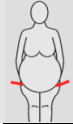
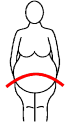




		Lap Belt			
		Flat Across Upper Thighs	Across Hips & Under Abdomen	Across Abdomen	Not Worn
					
Shoulder Belt					
Above both breasts		116 (6.0)	35 (1.8)	135 (7.0)	21 (1.1)
Across one breast & across abdomen		117 (6.0)	109 (5.6)	119 (6.2)	10 (0.5)
Between breasts & around abdomen		231 (12.0)	✓ 83 (4.3) ✓	452 (23.4)	21 (1.1)
Off shoulder & around abdomen		119 (6.2)	28 (1.4)	152 (7.9)	12 (0.6)
Not worn		1 (0.0)	0 (0.0)	10 (0.5)	160 (8.3)
Total		584 (30.2)	255 (13.2)	868 (44.9)	224 (11.6)

Table 3. Seatbelt positioning numbers (and %) for European pregnant women: Proportion of the ‘Correct use’ of three-point seatbelt is 5.2%. (✓ Correct seatbelt position).



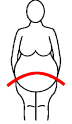


		Lap Belt			
		Flat Across Upper Thighs	Across Hips & Under Abdomen	Across Abdomen	Not Worn
					
Shoulder Belt					
Above both breasts		82 (6.6)	21 (1.7)	86 (7.0)	7 (0.6)
Across one breast & across abdomen		76 (6.1)	68 (5.5)	76 (6.1)	7 (0.6)

Table 3. Cont.




		Lap Belt				Not Worn	Total
		Flat Across Upper Thighs	Across Hips & Under Abdomen		Across Abdomen		
Between breasts & around abdomen		168 (13.6)	✓ 64 (5.2) ✓		313 (25.3)	10 (0.8)	555 (44.9)
Off shoulder & around abdomen		71 (5.7)	22 (1.8)		94 (7.6)	4 (0.3)	191 (15.4)
Not worn		0 (0.0)	0 (0.0)		3 (0.2)	64 (5.2)	67 (5.4)
Total		397 (32.1)	175 (14.2)		572 (46.3)	92 (7.4)	1236

Table 4. Seatbelt positioning numbers (and %) for North American pregnant women: 'Proportion of the 'Correct use' of three-point seatbelt is 3.5%. (✓ Correct seatbelt position).










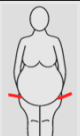


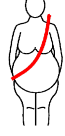


		Lap Belt					
		Flat Across Upper Thighs	Across Hips & Under Abdomen	Across Abdomen	Not Worn	Total	
							
Shoulder Belt							
Above both breasts		6 (2.3)	3 (1.2)	14 (5.4)	3 (1.2)	26 (10.1)	
Across one breast & across abdomen		19 (7.4)	16 (6.2)	19 (7.4)	0 (0.0)	54 (20.9)	
Between breasts & around abdomen		27 (10.5)	✓ 9 (3.5) ✓		71 (27.5)	6 (2.3)	113 (43.8)
Off shoulder & around abdomen		13 (5.0)	2 (0.8)	22 (8.5)	3 (1.2)	40 (15.5)	
Not worn		0 (0.0)	0 (0.0)	4 (1.5)	21 (8.1)	25 (9.7)	
Total		65 (25.2)	30 (11.7)	130 (50.3)	33 (12.8)	258	

Table 5. Seatbelt positioning numbers (and %) for pregnant women from Other Countries: 'Proportion of the 'Correct use' of three-point seatbelt is 2.3%. (✓ Correct seatbelt position).


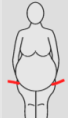





		Lap Belt			
		Flat Across Upper Thighs	Across Hips & Under Abdomen	Across Abdomen	Not Worn
					
Shoulder Belt					
Above both breasts		28 (6.4)	11 (2.5)	35 (8.0)	11 (2.5)
Across one breast & across abdomen		22 (5.0)	25 (5.7)	24 (5.5)	3 (0.7)
Between breasts & around abdomen		36 (8.2)	✓ 10 (2.3) ✓	68 (15.5)	5 (1.1)
Off shoulder & around abdomen		35 (8.0)	4 (0.9)	36 (8.2)	5 (1.1)
Not worn		1 (0.2)	0 (0.0)	3 (0.7)	75 (17.1)
Total		122 (27.9)	50 (11.4)	166 (37.9)	99 (22.6)

3.2. The Most Common Incorrect Positions

Correct positioning rate for the entire seatbelt is very low for the population. The combination percentages are summarised in Table 6. The most common lap section misuse is positioning it 'Across abdomen'. The second most common lap belt misuse is the 'flat across upper thighs' position. However, the shoulder section of the seatbelt is most commonly used correctly. The most common shoulder section misuse in Europe and North America is 'across one breast and across abdomen' and 'above both breasts' for Other Countries.

The largest numbers in the matrix in Table 6 reveal that even when the shoulder section is correctly positioned, the lap section misuse 'across the abdomen' is a problem for almost one in four pregnant women. Not wearing the seatbelt appears to be the most important issue in Other Countries.

Table 6. Summary of the seatbelt use and the most common mistakes (percentages). (✓/ Correct seatbelt position); the largest percentages are shown in *italic and bold*.

		Lap Belt			
		Flat Across Upper Thighs	Across Hips & Under Abdomen	Across Abdomen	Not Worn
					
Shoulder Belt					
Above both breasts		All Regions: 6.0 Europe: 6.6 N America: 2.3 Other C's: 6.4	All Regions: 1.8 Europe: 1.7 N America: 1.2 Other C's: 2.5	All Regions: 7.0 Europe: 7.0 N America: 5.4 Other C's: 8.0	All Regions: 1.1 Europe: 0.6 N America: 1.2 Other C's: 2.5
Across one breast & across abdomen		All Regions: 6.0 Europe: 6.1 N America: 7.4 Other C's: 5.0	All Regions: 5.6 Europe: 5.5 N America: 6.2 Other C's: 5.7	All Regions: 6.2 Europe: 6.1 N America: 7.4 Other C's: 5.5	All Regions: 0.5 Europe: 0.6 N America: 0 Other C's: 0.7
Between breasts & around abdomen		All Regions: 12.0 Europe: 13.6 N America: 10.5 Other C's: 8.2	✓✓ All Regions: 4.3 Europe: 5.2 N America: 3.5 Other C's: 2.3	All Regions: 23.4 Europe: 25.3 N America: 27.5 Other C's: 15.5	All Regions: 1.1 Europe: 0.8 N America: 2.3 Other C's: 1.1
Off shoulder & around abdomen		All Regions: 6.2 Europe: 5.7 N America: 5.0 Other C's: 8.0	All Regions: 1.4 Europe: 1.8 N America: 0.8 Other C's: 0.9	All Regions: 7.9 Europe: 7.6 N America: 8.5 Other C's: 8.2	All Regions: 0.6 Europe: 0.3 N America: 1.2 Other C's: 1.1
Not worn		All Regions: 0 Europe: 0 N America: 0 Other C's: 0.2	All Regions: 0 Europe: 0 N America: 0 Other C's: 0	All Regions: 0.5 Europe: 0.2 N America: 1.5 Other C's: 0.7	All Regions: 8.3 Europe: 5.2 N America: 8.1 Other C's: 17.1
Total		All Regions: 30.2 Europe: 32.1 N America: 25.2 Other C's: 27.9	All Regions: 13.2 Europe: 14.2 N America: 11.7 Other C's: 11.4	All Regions: 44.9 Europe: 46.3 N America: 50.3 Other C's: 37.9	All Regions: 11.6 Europe: 7.4 N America: 12.8 Other C's: 22.6

100

3.3. Further Information

The questionnaire also included questions to investigate pregnant women's 'safety concerns' and their awareness of 'available information'. Almost all pregnant women expressed concerns about safety whilst using the seatbelt. Table 1 shows that a majority still carry on wearing seatbelts during pregnancy. However, some pregnant women reported that they ceased using the seatbelt due to fear that the seatbelt might harm the fetus in a collision.

A very common problem during the course of a car journey is that initially correctly positioned and tightened seatbelt over the pelvic bones under the abdomen can develop slack due to movements and have a natural tendency of gradually moving over the abdomen. It is gradually harder for the lap belt to stay over the pelvic bones under the growing abdomen as the pregnancy progresses. This is both uncomfortable and causes concern. Anecdotal evidence suggests that women occasionally hold the belt away from the bump with their hands or thumbs or use positioners to prevent the lap belt from riding up the pregnant abdomen to protect the fetus. Similarly, some women also hold the shoulder belt away from their neck because it cuts and rubs their neck.

According to our sample, 46% pregnant women in Europe, 48% in North America, and 35% in Other Countries can find advice on seatbelts by actively seeking information from medical authorities, books, friends, relatives, and the Internet. Acar and Weekes [24] suggested that the automotive industry and powerful media sources such as the television, as well as nurses, midwives, and doctors, can play an influential part in awareness campaigns. Only 1% of women in the sample reported receiving advice from an automotive industry source.

4. Discussion

This study investigates the correct and incorrect use of the shoulder and lap section of the three-point seatbelt by pregnant occupants. Unlike earlier studies, investigation of 'correct use' has no room for misinterpretations in this study since it is essential to use the three-point seatbelt 'correctly' not 'correctly in part' to secure the intended protection.

We did not use accident databases, as none of the detailed seatbelt use data were recorded in current databases. Both European and North American data represent pregnant women from different countries and states. However, Other Countries data represent intrinsically diverse cultures. The tables reveal that the worst overall seatbelt problem in Other Countries is 'not wearing the seatbelt', with a 17.1% rate. Further investigation is needed in Other Countries to fully understand the cultural habits and patterns.

4.1. Comparison with Previously Published Studies

The 'correct positioning of the seatbelt' rates reported in this study are significantly lower than previously published studies. Previous studies described the correct lap belt position as underneath the abdomen. However, this did not clearly distinguish between the (incorrect) position 'lap belt across the upper thighs' and the correct position according to guidelines 'across the hips'. Therefore, it is not surprising that Arneson et al. [14], Hammond et al. [15], Johnson and Pring [11], and McGwin et al. [18] reported a high incidence of correct lap belt positioning such as approximately 40–79%. In this study, the incorrect 'flat across the upper thighs' and correct 'across hips and under abdomen' data are classified into two separate groups in order to investigate the real correct use rate of the lap section. In fact, if these two categories of our study were combined, all regions data would give the result of 43.4%, which is within the range of earlier researchers' results.

The papers by McGwin et al. [18] and Pearlman and Phillips [23] state the shoulder belt should pass 'between the breasts' with no clear definition of how the shoulder belt should pass over the shoulder. Their correct seatbelt positioning ratios of 91% and 53–68%, respectively, might include instances where the shoulder belt is correctly positioned between the breasts, or it might be incorrectly placed off the shoulder in those studies. Likewise, if these two categories were combined, all regions data would give a comparable result of 65.9%.

Therefore, this investigation reveals the 'correct' lap and shoulder section positioning during pregnancy and identifies the common seatbelt misuses.

4.2. Limitations

Any questionnaire survey relies on the sincerity of the participants. We acknowledge the fact that the online Questionnaire could be accessible by anyone on the internet. However, it was publicised in pregnant women-related domains only.

Combined sample findings are focused upon as it should present a broader picture. However, the majority of the data was collected from Europe (64%), followed by Other Countries (23%). North America forms 13% of the sample. We acknowledge potential significant cultural variations represented within each of these groups. The questionnaire was only available to pregnant women who have access to the Internet and who spoke one of the five languages. This means that the Other Countries sample represents a mixed group of women whose native language is one of the five languages or educated women who could speak a foreign language. The participating pregnant women declared that they searched or found the questionnaire pro-actively and hence the authors acknowledge that the findings might have been biased toward the representation of more educated and safety-conscious women.

5. Conclusions

The shoulder and lap portions of the seatbelt are two integral parts of a whole system playing joint roles in the safety of the car occupant and therefore should be correctly positioned simultaneously as advised so that seatbelts can be expected to operate as intended. This research provides evidence that the clear, unambiguous definition is essential in investigations to understand the real incorrect seatbelt wearing rates among pregnant women.

According to the analysis of 1931 questionnaire responses, the overall seatbelt use during pregnancy is 91.9%, which is reasonably high. However, the results showed that a very low proportion, only 4.3% of pregnant women, positioned their entire seatbelts correctly.

Three out of four women appear to be positioning their lap section either 'across abdomen' or 'flat across the upper thighs'. Correctly worn three-point seatbelts are crucial restrain systems for the safety of both fetus and pregnant women as investigated by the authors. We therefore recommend that the advice given to pregnant women should emphasise the importance of both parts of the belt for correct positioning of the entire seatbelt.

This study also reveals that pregnant women actively seek information about seatbelt use in pregnancy. Only 1% of participant women reported receiving information from an automotive industry source. Discomfort is one of the causes for pregnant women not wearing a seatbelt. Hence, improving safety for pregnant drivers and passengers requires a combined approach from media, the medical community, and the automotive industry to provide widely available information about correct seatbelt use during pregnancy.

Further regional investigations are needed for the seatbelts. We also suggest accident databases include 'correct' seatbelt usage in crash statistics for further research and analysis. Results of this research demonstrate that the correct use of three point seatbelts is a challenge during pregnancy.

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Author Contributions: B. Serpil Acar supervised the project, conceptualized the study, coordinated and supervised data collection, analysed and interpreted the data and wrote the paper. Alix M. Edwards contributed to study through website design and development, data collection and initial analysis of data. Mostafa Aldah assisted in further data collection and analysis of data.

Conflicts of Interest: The authors declare no conflict of interest.

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