

## UNIVERSITY OF AUCKLAND

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Do pregnant women who report reduced fetal movements have objective evidence of reduced fetal movements?

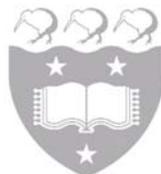


The University of Auckland; Faculty of Medical and Health Sciences

### **SCHOLARSHIP IMPACT REPORT**

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31 January 2019



## Thank You and Summary

I would like to begin this report by acknowledging and giving thanks to the University of Auckland, whose generous grant made it possible for me to work on this project for 10 weeks over summer. I extend my gratitude to the selection committee for offering me the scholarship and allowing me the opportunity to be involved in such an enriching learning experience.

The project I have been working on was born out of the accepted notion that fetal movement is a measure of fetal wellbeing. Monitoring of fetal movement is thus an important part of obstetric medicine. Before I joined the project, my supervisor Emeritus Professor Edwin Mitchell and his team had been testing a new fetal movement device on pregnant New Zealand women. My job was to analyse these recordings and write up my findings with reference to relevant literature.

I have always had a particular interest in fetal medicine and the physiology of pregnancy, hence my desire to work on this project. However, the studentship exceeded all my expectations. This is in massive part due to Professor Mitchell whose passion and excellence in his field are inspiring and whose willingness to welcome me, guide me and pass on his knowledge to me made my time in the Department incredibly worthwhile and enlightening.

As well as physiological, epidemiological and clinical knowledge, I gained insight into the ways in which health research is carried out and the array of skills which are useful in a research team. What I came to realize and came to love is that research is not a straight forward task but instead a constant problem-solving exercise, demanding flexibility and positivity from those involved, that ultimately leaves you with a great sense of achievement and reward.

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## Input

The grant I received from the University of Auckland enabled my involvement in the fetal movement study, however the study as a whole would not have been possible if it weren't for funding from Cure Kids, who provided a two-year grant towards research into stillbirth prevention in New Zealand. I am grateful for their contribution to make this project possible.

Furthermore, I must acknowledge and thank Dr Ryo, Kyoko Nishihara and their research team from Teikyo University in Japan who produced a fetal movement detection device and agreed to lend it to us so we could carry out fetal movement studies on a New Zealand population of pregnant women. They contributed valuable instructions, insights and advice when we were using the device and analysis software.

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## Research Activity

As previously mentioned, fetal movements are a measure of fetal wellbeing. Maternal perception of reduced fetal movements (RFM) is associated with fetal growth restriction<sup>1,2</sup> and late stillbirth<sup>3,4</sup>. Currently, the best method of assessing fetal movements is via ultrasound (US), however this measurement is momentary. Maternal awareness of fetal movement, such as “kick counting”, is another method of monitoring but has not been shown convincingly to reduce stillbirths<sup>5,6</sup>. Therefore, there is a need for continuous, long-term fetal monitoring which may enable more effective detection of fetal problems and early intervention<sup>7</sup>.

The device which Dr Ryo and his colleagues in Japan developed is called a fetal movement acceleration measurement (FMAM) recorder and can detect fetal movement at home over extended periods of time. Preliminary studies have shown the FMAM recorder to produce almost identical readings to ultrasound scanning<sup>8</sup>. In addition to the device, the Japanese group have produced analysis software for reading the obtained data.

Normal reference values for the FMAM recorder have been published however these were collected from an exclusively Japanese population of which the mean body mass index (BMI) was 21.0kg/m<sup>2</sup><sup>9</sup>. In contrast, 61% of women in New Zealand are either overweight or obese (BMI >25.0kg/m<sup>2</sup>)<sup>10</sup>. In order for the FMAM recorder to be a universally useful tool, further investigation into the effectiveness and reliability of the device across ethnicities, populations and maternal weight ranges is required. Hence, the aim of this study was to assess the efficacy of the FMAM in a NZ population with high prevalence of maternal obesity. We hypothesised that maternal obesity might result in an apparent reduction of fetal movements but that the non-obese population reference values would be similar to those recorded in Japanese women. We were interested in fetal hiccups as well as gross fetal movement, as maternal perception of fetal hiccups is protective against stillbirth<sup>4</sup>. Fetal hiccups are very similar to adult hiccups and are a normal activity of the fetus, characterised as sudden, quick, fetal movements occurring at regular intervals<sup>11</sup>.

We also had the opportunity to assess three clinical groups, (1) women presenting in late pregnancy with reduced fetal movements (RFM), (2) a group of mothers who had symptoms of supine hypotension (SH), and (3) infants who were born small for their gestational age (SGA).

Our “normal” women were recruited from the National Women’s Hospital, Auckland through word-of-mouth and via their midwives and were then divided into a normal weight group (BMI <30kg/m<sup>2</sup>) and an obese group (BMI >30kg/m<sup>2</sup>). Our SGA group (small babies) and RFM group were recruited from the Acute Assessment Unit (AAU) at Auckland City Hospital. Mothers with symptoms of supine hypotension were recruited via their midwives and placed in the SH group.

A research assistant visited the homes of the subjects to set up the apparatus, apply the FMAM sensors and instruct the mothers on how to use the device to record fetal movement. Each mother recorded their babies movements over one night while they slept and the data was collected the following day.

My role in the project was to clean and analyse the data and summarise the results. I used automatic analysis software which processed the signals, removed noise, performed fetal movement counting and identified fetal hiccups. Before the analysis could be performed I had to compare FMAM signals with brain activity signals to find each mothers sleep and wake time. Furthermore, the analysis software was not perfect and each dataset had to be manually scanned for artefacts.

Once the data had been exported to spreadsheets, I carried out statistical analysis in order to compare the normal and obese pregnant women, as well as the three clinical subgroups. In conjunction with my review of the current literature, I then identified the significant findings and wrote a report which I hope will go on to be published.

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## Research Output(s)

Our final results included 87 pregnant women and 87 newborns, all of which produced good fetal movement recordings. The gestation at recording ranged from 34 to 38.7 weeks with an average of 36.2 weeks across all groups. Ethnicity was diverse across the women with more than half identifying as non-European. Please see **table 1** in the appendix for more detail of the subject characteristics.

When we compared our “normal” women with Japanese women, the mean fetal movements per hour in the NZ group were 54.2 and in the Japanese group, were 45. The total time that fetuses spent moving was 11.3% for NZ women and 9% for the Japanese. These measures of fetal movement were found to be statistically similar between the two populations. In

contrast, fetal hiccups varied between the groups with the number of hiccups per hour being greater in NZ women (0.37) than in Japanese women (0.15).

Next, we compared our normal weight mothers with obese mothers and found that the mean number of fetal movements per hour in the normal and obese groups were 54.2 and 62.3 respectively and were not significantly different. The hiccup periods per hour, of the normal and obese groups, were 0.37 and 0.6 respectively and these were not significantly different either. Because the two groups were found to be statistically similar, we combined them to serve as our “normal” group against which we would compare our clinical groups.

We found that there was no significant difference in fetal movements across any of our clinical groups when compared to the “normal” mothers. I have included a box and whisker plot in the appendix which illustrates the average fetal movements per hour of the four groups. While the means do differ slightly, there is substantial overlap of all boxes and the groups are not significantly different.

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## Research Outcome(s)

The subjects in our normal group were all of a BMI < 30kg/m<sup>2</sup> and we hypothesised the FMAM would detect a similar number of fetal movements in normal NZ women as in Japanese women. Our results did in fact show that New Zealand pregnant women produce similar fetal movement measurements to Japanese pregnant women. This finding is assuring because it strengthens the reliability of the FMAM and suggests it could be utilised across diverse populations. In addition, our results were similar to those in a study which used ultrasound to find that fetuses at term move 7% of the time <sup>12</sup>.

We found that the FMAM was able to detect fetal hiccups in NZ women regardless of maternal BMI. The difference in hourly hiccup rates seen between NZ and Japan are likely due to variation in the settings of the analysis software and could be adjusted for in the future. The ability of the FMAM to detect fetal hiccups holds therapeutic potential as hiccup monitoring could be a means to pre-empt fetal demise.

All variables of fetal movement were similar between the normal and obese groups despite our hypothesis that they would differ. This finding was in agreement with a recent review which found that obesity does not impair maternal perception of fetal movement and that obese mothers who report reduced fetal movement should be regarded with as much concern as mothers in the normal weight range <sup>13</sup>. This finding is

promising as it suggests that the FMAM device could be utilised in obese women using the same reference values as for normal women.

There was no significant difference in fetal movement nor in hiccups between the normal women and women who reported their babies moving less. This is perhaps not surprising because all of these mothers went on to be assessed in the hospital and to give birth to healthy babies. Any mother whose baby was assessed to be at high risk was not included in the study.

There was no significant difference in movement of the small fetuses either. While epidemiological studies suggest that mothers who give birth to small babies are at higher risk of perceiving a reduction in fetal movements, our sample size was very small and the study was not powered to find significant differences in any of our clinical groups<sup>4</sup>. Rather, the point of the study was to test whether or not the FMAM could be used on a population of pregnant NZ women with high rates of obesity. We have been able to show that the FMAM can in fact be used on NZ women, to detect both fetal movement and fetal hiccups, and that BMI does not have an effect on the results.

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## **(Future) Impact**

Given that perception of reduced fetal movements carries a four times greater risk of stillbirth, our research has significant implications for future obstetric and fetal care. The FMAM is one of the few devices that is able to non-invasively monitor fetal movements over long-periods, at home, by mothers themselves. It is the only device of its kind which is able to detect fetal hiccups.

We have shown that the device is not only effective in a low-BMI, Japanese population but that it is also effective in an ethnically diverse group of women with a high prevalence of maternal obesity. This strengthens the efficacy of the FMAM device and more importantly it suggests that any non-invasive fetal movement monitoring can be carried out regardless of maternal BMI. Given that the global prevalence of obesity is rising and that obesity is a known risk factor for obstetric complications and poor fetal outcome, the importance of fetal movement monitoring, especially in obese women, is greater than ever.

Our pilot study has produced promising results however further work is required. The stillbirth rate in NZ in 2015 was 5.1 per 1000 births<sup>14</sup> and thus in order to effectively evaluate the FMAM recorder's feasibility in the prevention of stillbirth, it is evident that a much larger sample size would be required. Further studies would also need to include repeated recordings throughout the third trimester. Larger studies would enable us

to produce robust, normal reference values for the FMAM so that abnormal fetal movement could be identified. Abnormal fetal movement is suggestive of fetal distress and an early warning sign for fetal growth restriction, stillbirth and other abnormalities <sup>1-4</sup>.

In addition to monitoring gross fetal movements, the detection of fetal hiccups is a novel and promising means of detecting fetal compromise. Lack of fetal hiccups is correlated with poor fetal outcomes and as such, hiccups have been said to be protective <sup>4</sup>. If we were able to monitor fetal hiccup patterns (and/or detect abnormal gross fetal movement) we may be able to detect fetal demise at its early stages and therefore implement more timely and accurate interventions in the prevention of stillbirth and fetal growth restriction. The overarching goal of this would be to reduce stillbirths and fetal growth restriction in New Zealand.

## Appendix

**Table 1.** Characteristics of Subjects and Newborns

Variable	Number or mean (range)				
	Normal	Obese	SGA	RFM	SH
<b>Mothers</b>	17	16	18	17	19
<b>Age</b>	32.8 (22-42)	31.5 (18-43)	32.6 (24-42)	31.6 (20-42)	33.4 (22-39)
<b>BMI (kg/m<sup>2</sup>)</b>	26.7 (24.6-29.4)	36.8 (30-55.1)	28.9 (22.5-41.9)	28.3 (20-43.4)	28.6 (21-38)
<b>Primipara/Multipara</b>	16/1	7/9	12/6	9/8	8/11
<b>Newborns</b>	17	16	18	17	19
<b>Female/Male</b>	9/8	8/8	8/10	6/11	11/8
<b>European/Non-European</b>	7/10	6/10	9/9	6/11	12/7
<b>Gestation at Recording (weeks)</b>	36.3 (34.1-38.4)	35.9 (34.3-37.4)	36.1 (34-38.7)	36.3 (34.1-38.7)	36.3 (34.1-38)
<b>Gestation at Birth (weeks)</b>	39.5 (36.6-41.3)	39.7 (35.7-43)	39.0 (36.7-41.6)	39.6 (36.9-41.4)	39.7 (37.4-41.6)
<b>Birthweight (g)</b>	3436 (2700-4300)	3696 (2755-3815)	2711 (2300-3375)	3463 (2060-4950)	3545 (2600-4800)
<b>Centile</b>	45 (12.2-93.6)	45.3 (12.3-98.7)	4.4 (0.4-9.8)	40.9 (1-99.9)	48.3 (2.6-98.1)

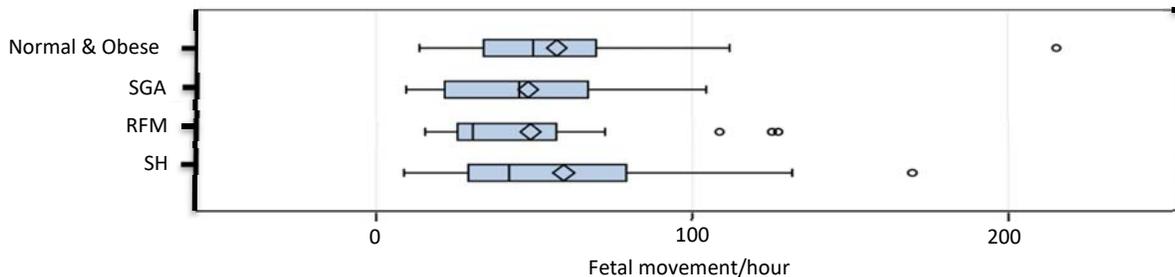
**Table 2. Normal and Obese FMAM Results**

Normal (n=17) vs Obese (n=16)	Normal	Obese	P Value
	Mean (SD)	Mean (SD)	
Fetal movements per hour	54.2 (28.5)	62.3 (45.3)	0.54
Fetal movement ratio	11.3 (5.4)	12.8 (7.4)	0.53
Hiccups periods per hour	0.37 (0.3)	0.6 (0.7)	0.16
Hiccup period average duration (mins)	2 (1.4)	2.2 (1.9)	0.71
Total sleep time (hours)	7.9 (0.7)	7.5 (1.5)	0.36

**Table 3. Normal and Obese FMAM results combined compared to SGA, RFM and SH FMAM results**

Normal & Obese (n=33) vs SGA (n=18), RFM (n=17) and SH (n=19)	Normal & Obese	Small for gestational age	P Value	Reduced fetal movements	P Value	Supine hypotension	P Value
	Mean (SD)	Mean (SD)		Mean (SD)		Mean (SD)	
Fetal movements per hour	58.1 (37.3)	46 (26.9)	0.23	48.6 (37.1)	0.40	59.3 (42.4)	0.92
Fetal movement ratio	12 (6.4)	9.8 (5.5)	0.23	10.2 (7.3)	0.36	12.2 (8.0)	0.93
Hiccups periods per hour	0.5 (0.53)	0.36 (0.26)	0.21	0.26 (0.51)	0.14	0.33 (0.23)	0.12
Hiccup period average duration (mins)	2.1 (1.6)	2.8 (1.9)	0.18	2.1 (2.4)	0.92	3.1 (2.0)	0.054
Total sleep time (hours)	7.7 (1.2)	7.8 (1.1)	0.93	7.4 (1.1)	0.38	7.7 (1.1)	0.86

**Figure 1. Box and whisker plot of normal & obese fetal movements per hour compared to SGA, RFM and SH fetal movements per hour.**



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