University of Zurich UZH

Master Program in Biostatistics
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STA490: Statistical Consulting

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Changes in the frequency and distribution of birth lacerations in women with subsequent births at the University Hospital Zurich (USZ)

Analysis for Dr. Nina Kimmich, University Hospital of Zurich

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Version of May 14, 2019

1 Introduction

Laceration or tears are common in vaginal births. The care of mothers in obstetrics involve the long-term care of birth tears during child birth. Tears, as we will refer in this report, are common in vaginal births and have side effects of pain, urinal and bowel incontinence (ACOG, 2011), which impacts on the mother's activities of daily living, and the care for her child. The motivation of this study is to improve the knowledge of tears during childbirth. Clinical experience of the client show that tears differ between women who have given birth to their first child compared to those who have given birth to one or more children before. Clinicians do not know which maternal, fetal or obstetrical factors influence the occurrence of which type of tear or the influence of sustained tears to the frequency and distribution of subsequent births by the same woman. The aim of this statistical anaylsis is to evaluate the frequency and distribution of the different types of tears grouped by parity, which is defined as the number of times a woman has carried a pregnancy to a viable gestational age of 20 weeks.

2 Research Questions

1. What is the frequency and distribution of the different types of birth lacerations within parity groups?
2. Which factors influence the distribution or the presence of the different lacerations in the parity groups?
3. Do the sustained tear patterns in the past influence the patterns in a subsequent birth?

3 Methods

Study Design

Type of study

This was a retrospective study.

Study population

The study population included all women with subsequent vaginal births of a singleton child in vertex presentation at the University Hospital of Zurich between 01.01.2005 and 31.12.2016. These were women of at least age 18, whose birth is at term (at least 37 weeks). We excluded births where there were fetal malformations, multiple pregnancies, transverse/breech positions.

Data collection

For the eligible patients, data on maternal, obstetrical and fetal factors have been collected. Table 1 contains a list of these factors along with their units of measurements and possible values. For birth mode, there are three types: spontaneous, spontaneous with Kristeller or vacuum. Births can be aided by the Kristeller manouever which is an application of manual pressure to the upper part of the uterus. The quality of the fetal heart rate (CTG or Cardiotocography) refers to the physiological condition of the fetus. This study categorised the "CTG" as being within physiological ranges or "physiol", in pathological ranges as "path", or suspicious as "suspic". The fetal position can be understood as "Dorsal-Posterior", where the spinal curvature of the fetus is aligned to its mother's, and "Dorsal-Anterior", is where this is the opposite. "Left" and "Right" Dorsal-Anterior or Dorsal-Posterior indicate the direction of the fetal rotation within the birth canal. "FACE" is when the fetus' face can be visualised in the birth canal, and "FOREHEAD" is where its forehead is visualised in the same location. The APGAR is a measure of the newborn's physical condition. It is a scoring system of its heart rate, respiratory effort, muscle tone, response to stimulation, and skin coloration whereby ten is the best score and the best physical condition. In this study, it is used as outcome variable recorded as below or above 7, "APGARbelow7". The variable "pHNSAbelow7.15" indicates whether the pH of a blood sample from the umbilical artery is above or below 7.15. Blood loss is another outcome variable measured in mL whereby a loss up to 500 mL is considered normal and a higher blood loss is abnormal and classified as "postpartum haemorrhage".

Primary and secondary outcomes

For each birth, up to three different tears have been recorded from seven types as seen in Table 2. Note that two tears are of special nature, 'Intact" means that there are actually no tears endured. "Episiotomy" means that the sustained tear has been through a surgical cut. The perineal tears occur in the perineum and their grade or intensity is represented by lower grade at '1+2" and higher grade at "3+4". There are three secondary outcomes: Blood loss, and the binary outcomes of APGAR and pH as described above.

Statistical Analysis

Data Preparation

Data was read from an excel file provided by the client by using `readxl` (Wickham and Bryan, 2019). German terms were translated to English. Tear names in English were then abbreviated into tear codes.

Table 1: Impact factors and their units of measurement of possible values.

Impact factors	Units of measurement / levels
Parity	number of births
Age	maternal age in years
BMI	kg/m2
Ethnicity	1 = caucasian, 2 = non-caucasian
Age of gestation	days
Birth mode	spontaneous, spontaneous with Kristeller, vacuum
Analgesia	1 = epidural, 2 = other, 3 = none
Duration of 2nd stage	minutes
Duration of pushing phase	minutes
Quality of fetal heart rate	physiological (physiol), suspicious (suspic), pathological(path)
Fetal position in the birth canal	Dorso-Anterior Left (DA_L), Dorso-Anterior Right (DA_R), Dorso-Posterior Left (DP_L), Dorso-Posterior Right (DP_R), Face, Forehead
Fetal weight	g
Head circumference	cm

Table 2: Seven single tear types and their abbreviations. Up to three single tears are recorded as a tear pattern from each birth.

Tear name	Tear code
Intact or no tear	I
Labial tear	L
Vaginal tear	V
Paraclitoral tear	P
Perineal grade 1+2	P1+2
Perineal grade 3+4	P3+4
Episiotomy	E

The tear codes representing each tear of the maximally three tears per birth were concatenated. The concatenated tear codes will be called tear patterns. Several revisions on the analytical side prompted revisions by the client due to checks for clinically meaningful data. These were to ensure that:

1. no records appeared with the same tear twice
2. no records with intact tear as an entry and an actual tear
3. no records with epistomy and perineal 1+2 tears
4. no record with the same patient ID appears twice with same parity.

Additionally, women with only one birth have been eliminated from the data set.

Descriptive Statistics and Simple Methods

To address Research Question 1, I took counts of tears and tear patterns by parity using package `janitor` (Firke, 2018), `stats` (R Core Team, 2018a), `tableone` (Yoshida, 2019) and package `dplyr` (Wickham et al., 2019).

To address Reseach Question 2, package `tableone` (Yoshida, 2019) was used. Means and standard errors were calculated for continuous variables. Counts and percentages were calculate for categorical variables. The p-value was calculated by the same package which used a chi-squared test for categorical variable and a one-way F-test for continuous variables at level 5%. It is formatted at 3 decimal places by default, and prints <0.001 for very small values. The tables were visualised with the aid of package `kableExtra` (Zhu, 2019).

To address Research Question 3, I used conditional counts of tear patterns and parity in a mosaic plot, which will be described later in the Visualisation Methods.

The other outcome variables of Blood loss, APGAR and pH are described in a frequency table created by `janitor` (Firke, 2018) and `dplyr` (Wickham et al., 2019).

Visualization Methods

A mosaic plot was used with the package `ggmosaic` (Jeppson et al., 2018) with colour schemes by package `viridis` (Garnier, 2018) and `RColorBrewer` (Neuwirth, 2014). A mosaic plot is a graphical summary of the conditional distributions in a contingency table and graphically plots two or more qualitative variables. The ten most frequent tear patterns were visualised in this report. The tear patterns are always ordered in two ways in this report. One order is by descending order of the ten most frequent tear patterns from lowest on the top of the Y-axis. The other is by the clinician's choice which represents a more clinically relevant order and is unordered by any numerical measure. Each mosaic plot in this report is produced twice with each of the two orders.

To address Research Question 1, a mosaic plot was used where the ten tear patterns are displayed on the Y-axis and parity 1, 2, 3, 4 on the X-axis. The width of the entire X-axis and length for the entire Y-axis each equals to the proportion of 1. Each width and height per category represents the proportion of which that category takes amongst all of the categories of their respective axes.

To address Research Question 2, I used `ggplot2` (Wickham, 2016) packages to plot the conditional means of the continuous variables from Table 1 and parity in tile plots. The rectangular tiles are coloured accordingly, where the intensity of colour indicate the higher values of conditional means of this continuous variable, e.g. BMI of 30, for parity 1 births of tear pattern P1+2V appear as a more intense colour than a BMI of 21 for the same two values.

Table 3: Birth counts by parity 1 to 11.

Parity	n
1	1368
2	1730
3	742
4	202
5	51
6	12
7	7
8	4
9	2
10	1
11	1
Total	4120

Table 4: Birth counts by parity 1 to 4.

Parity	n
1	1368
2	1730
3	741
4	178
Total	4017

To address Research Question 3, I visualised 4 datasets for the subsequent births of parity 1 and 2, 2 and 3, 3 and 4. This visualisation was performed via the package `ggmosaic` (Jeppson et al., 2018) as well. In the mosaic plot, on both X and Y-axes are the ten most frequent tear patterns for each of the subsequent births. The ten most frequent tear patterns of the first of the subsequent births are on the X-axis. In the mosaic, a rectangular's horizontal width is the proportion of that particular tear pattern of the first parity, and the rectangular's vertical height is the proportion of that particular tear pattern of the subsequent parity. The tear pattern on the X and Y-axes are arranged in two different orders as mentioned above. Thus two plots of each of the four subsequent births were produced.

I also analysed other outcome variables in addition to answering the three research questions. I used a tile plot to show conditional means of blood loss given parities per tear pattern with package `ggplot2` (Wickham, 2016). I used spaghetti plots with the same packages to show the trajectory of tear patterns from parity 1 to 4, with the lines coloured by the head circumference value whereby the higher intensity of colour indicate higher head circumference value.

4 Results

4.1 Descriptive statistics

The original dataset contained 4120 births of parity 1 to 11, by 1892 women. Most births belonging to parity 2 as seen in Table 3. It was observed that the number of births markedly decreased from parity

Table 5: Frequency of seven singular tear types in descending order by parity 1 to 4. Each tear type is totaled per row. The number of tear types per parity is also recorded. This table is the same as Table 6 but is in reversed order of tear types.

Tear code	1	2	3	4	Total
P1+2	498	812	332	83	1725
I	121	548	327	85	1081
V	430	250	55	9	744
E	421	181	32	5	639
L	369	181	50	5	605
P	56	39	7	2	104
P3+4	27	11	3	0	41
Total	1922	2022	806	189	4939

Table 6: Frequency of seven singular tear types in ascending order by parity 1 to 4. Each tear type is totaled per row. The number of tear types per parity is also recorded. This table is the same as Table 5 but is in reversed order of tear types to aid the intepretation of Figure 1.

Tear code	1	2	3	4	Total
P3+4	27	11	3	0	41
P	56	39	7	2	104
L	369	181	50	5	605
E	421	181	32	5	639
V	430	250	55	9	744
I	121	548	327	85	1081
P1+2	498	812	332	83	1725
Total	1922	2022	806	189	4939

Table 7: Frequency of 28 tear patterns by parity in descending order. Each tear patterns is totaled per row. The number of tear patterns per parity are also recorded. This table is the same as 10 but in reversed order.

Tear pattern	1	2	3	4	Total
P1+2	240	596	276	72	1184
I	121	548	327	85	1081
E	325	160	29	5	519
P1+2V	101	114	31	6	252
L	111	62	22	1	196
V	94	78	18	3	193
P1+2L	85	70	20	4	179
VL	81	25	3	0	109
EV	59	11	1	0	71
P1+2VL	48	10	2	0	60
P1+2P	3	18	3	1	25
EL	14	6	2	0	22
P3+4	9	7	3	0	19
P	5	5	3	1	14
P1+2PV	11	3	0	0	14
PV	8	4	0	0	12
P1+2LP	10	1	0	0	11
PVL	7	3	0	0	10
PL	4	4	1	0	9
EVL	7	0	0	0	7
P3+4E	5	2	0	0	7
P3+4V	6	1	0	0	7
EP	5	1	0	0	6
P3+4EV	4	1	0	0	5
PVE	2	0	0	0	2
P3+4L	1	0	0	0	1
P3+4VL	1	0	0	0	1
P3+4PV	1	0	0	0	1
Total	1368	1730	741	178	4017

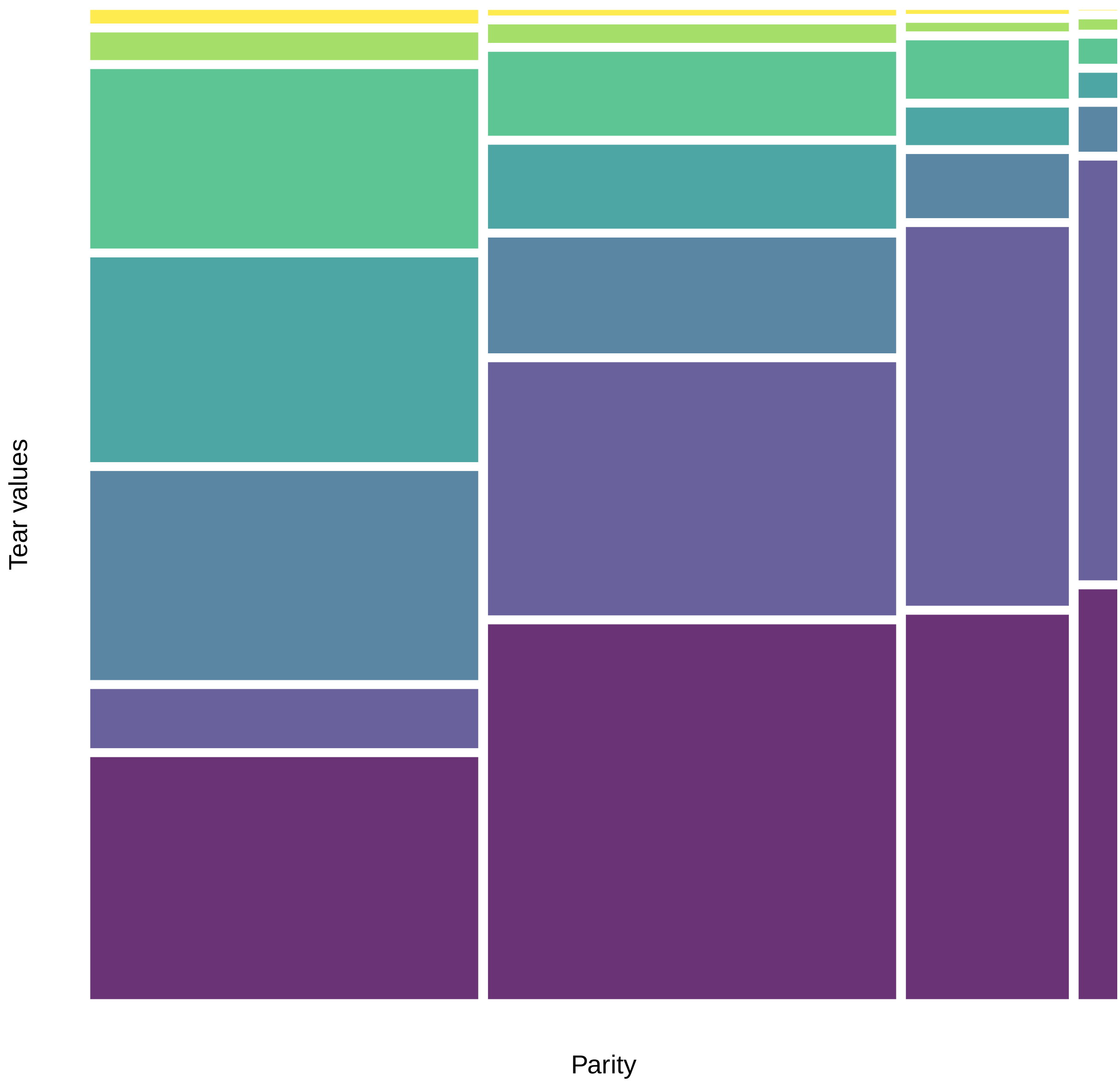

Figure 1: Frequency of seven tear types grouped by parity 1 to 4. The seven singular tears are ordered by the aggregated frequency from parity 1 to 4. The tear types are ordered from the most infrequent on the top of the Y-axis. The counts can be seen in Table 6.

Table 8: Frequency of ten most frequent tear patterns in descending order by parity 1 to 4. Each tear patterns is totaled per row. The number of tear patterns per parity are also recorded. This table is the same as Table 9 but is in reversed order.

Tear pattern	1	2	3	4	Total
P1+2	240	596	276	72	1184
I	121	548	327	85	1081
E	325	160	29	5	519
P1+2V	101	114	31	6	252
L	111	62	22	1	196
V	94	78	18	3	193
P1+2L	85	70	20	4	179
VL	81	25	3	0	109
EV	59	11	1	0	71
P1+2VL	48	10	2	0	60
Total	1265	1674	729	176	3844

5 to 11. So it was decided to restrict the parities from 1 to 4. Since every woman in the study had at least two births, we ensured that before restricting the data to parity 1 to 4, women of parity 5 and above, who had one other birth in parity 1 to 4, had that birth removed. Thus amongst all remaining births, there are at least two subsequent births of the same woman. This resulted in a total of 4017 births from parity 1 to 4 as seen in Table 4 by 1855 women. The table showing counts of births in parity 1 to 4 as seen in Table 4 also show that most births are of parity 2. The analysis of this report will henceforth reflect this restriction of parity 1 to 4.

The cumulative frequency of births belonging to both the parity 1 and 2 group is 1199 and has the highest frequency. This is followed by parity 2 and 3 group of 587 births, then parity 3 and 4 group of 158 births. The cumulative frequency of subsequent births of parity 1, 2, 3 is 202 births, and for parity 1 to 4 is 17 births. When these cumulative counts are compared to Table 4, most births of parity 1 are subsequent with parity 2. Lesser births of parity 2 are subsequent with parity 3. The cumulative frequency of births decrease with higher subsequent groups.

There were 4939 tears recorded from parity 1 to 4. Most tears are recorded in parity 2, followed by parity 1. The most frequent tear is P1+2, followed by no tears and V as seen in Table 5. Table 5 is the same as Table 6 but in reverse order. The latter table was created to aid the interpretation for Research question 1.

Furthermore, the primary outcome was observed to contain 28 unique tear patterns. As parity increases, there are lesser unique tear patterns ocurring as seen in Table 7, where tear patterns are listed in descending order and Table 10, where they are listed in ascending order. The ten most frequent tear patterns were taken from aggregated ranking of parity 1 to 4, seen in descending order in Table 8. In the 28 tear patterns, I observe that tear patterns containing single tears are all present and tear patterns with three tears are infrequent. In the ten most frequent tear patterns, there are five tear patterns that contain only 1 tear (singular tear patterns of P1+2, I, E, L and V), and only 1 tear pattern contains 3 tears P1+2VL. A single P1+2 tear is the most frequent tear pattern. “I” or intact is the second most frequent tear pattern.

Table 9: Frequency of ten most frequent tear patterns in ascending order by parity. Each tear type is totaled per row. The number of tear types per parity is also recorded. This table is the same as Table 8 but is in reversed order to aid the intepretation of Figure 2.

Tear pattern	1	2	3	4	Total
P1+2VL	48	10	2	0	60
EV	59	11	1	0	71
VL	81	25	3	0	109
P1+2L	85	70	20	4	179
V	94	78	18	3	193
L	111	62	22	1	196
P1+2V	101	114	31	6	252
E	325	160	29	5	519
I	121	548	327	85	1081
P1+2	240	596	276	72	1184
Total	1265	1674	729	176	3844

4.2 Research question 1

Parity 2 has the highest number of tears as seen in Figure 1 and Table 6. In parity 1, out of 1922 tears, the most frequent tear is P1+2 (498) followed by V (430), then E. In parity 2, out of 2022 tears, the most frequent tear is P1+2 (812), followed by no tear or I (548), V (250) and L (181). In parity 3, the most women have P1+2 (332) tears followed by no tear or I (327). Both these categories take up most of the counts of tears out of all tears recorded in parity 3 (806). The lowest number of tears are recorded in parity 4, where the highest frequency category is no tear, (85), followed by P1+2 (83). It is observed that births of higher parity have higher frequency of no tears and P1+2 tears.

The mosaic plot in Figure 2 and Figure 3 show the ten most frequent tear patterns for parity 1 to 4 in descending order and the clinician's order on the Y axis respectively. Figure 2 can be read with Table 9. I note that as with Figure 1, parity 2 has the highest number of tears. P1+2 and no tears increases in relative frequency with higher parities, whilst Episiotomy as a singular tear or as part of a tear pattern "EV" decreases in relative frequency with higher parities.

When observing all 28 tear patterns by parity from parity 1 to 11, as seen in Table 7, I note that the relative frequency of P1+2 and no tear also increases with parity. P1+2 reflect as the highest count of tears across all parities, followed by no tear. A single episiotomy has the third highest counts as a tear pattern, particularly in parity 1. Labial tears are also a frequent tear pattern but decrease markedly with increase in parity. The counts of tear patterns in descending order is seen in Table 7 and in ascending order is seen in Table 10. The latter table was created to aid the interpretation of tile plots in Research question 2.

4.3 Research question 2

The results of influencing factors for Research Question 2 are seen in Table 11. The tile plots should be read alongside Table 10 to reflect the denominators of each conditional mean. The means of the BMI and maternal age increase with increasing parity. A high proportion of women in parity 1 to 3 are caucasian, and nearly half of women in parity 4 are non-caucasian. There are no marked differences in the gestational age in weeks. Most birth modes of parity 1 are spontaneous, followed by spontaneous

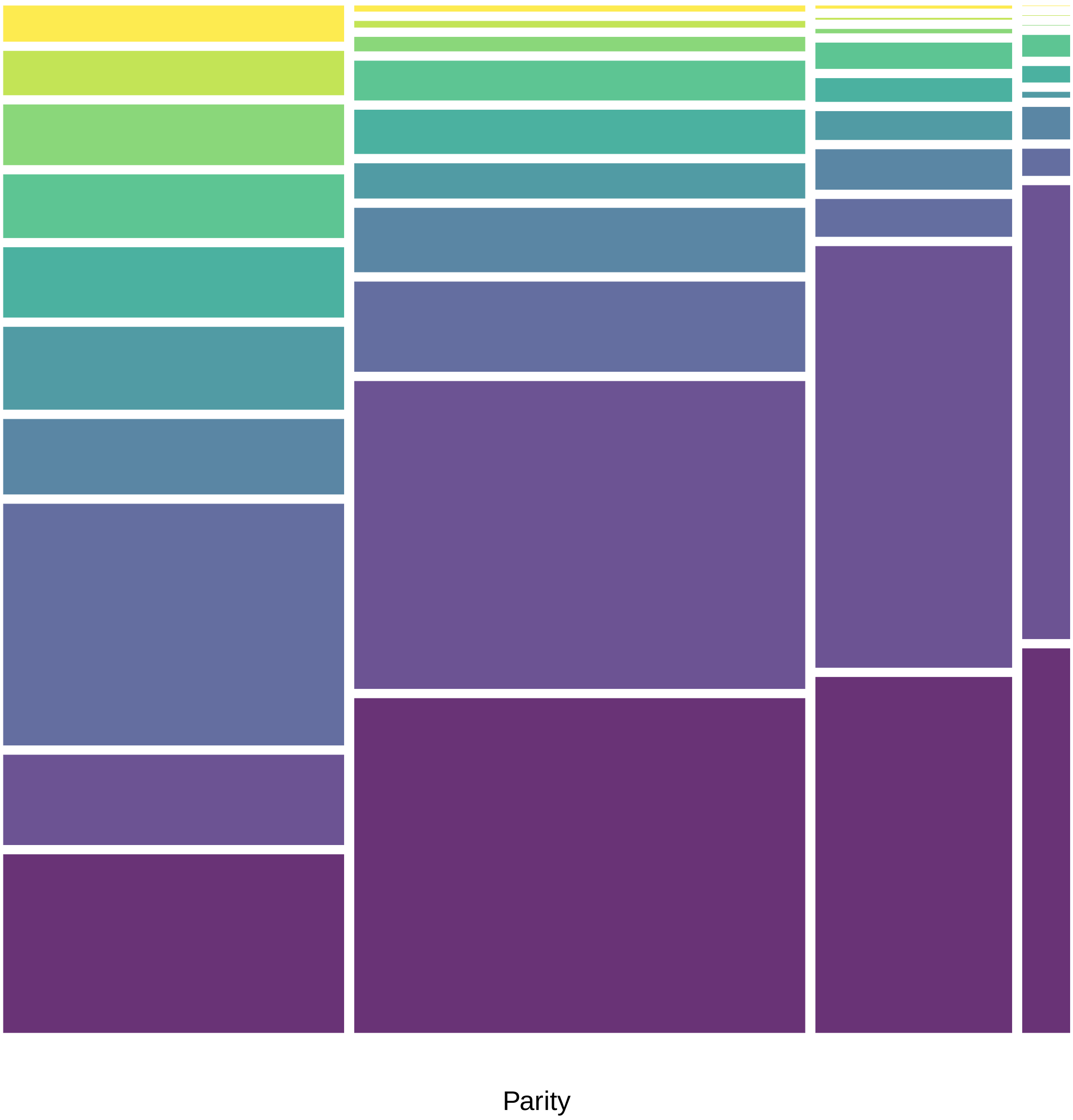

Figure 2: Frequency of ten most frequent tear patterns grouped by parity. The ten tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. The counts can be seen in Table 9.

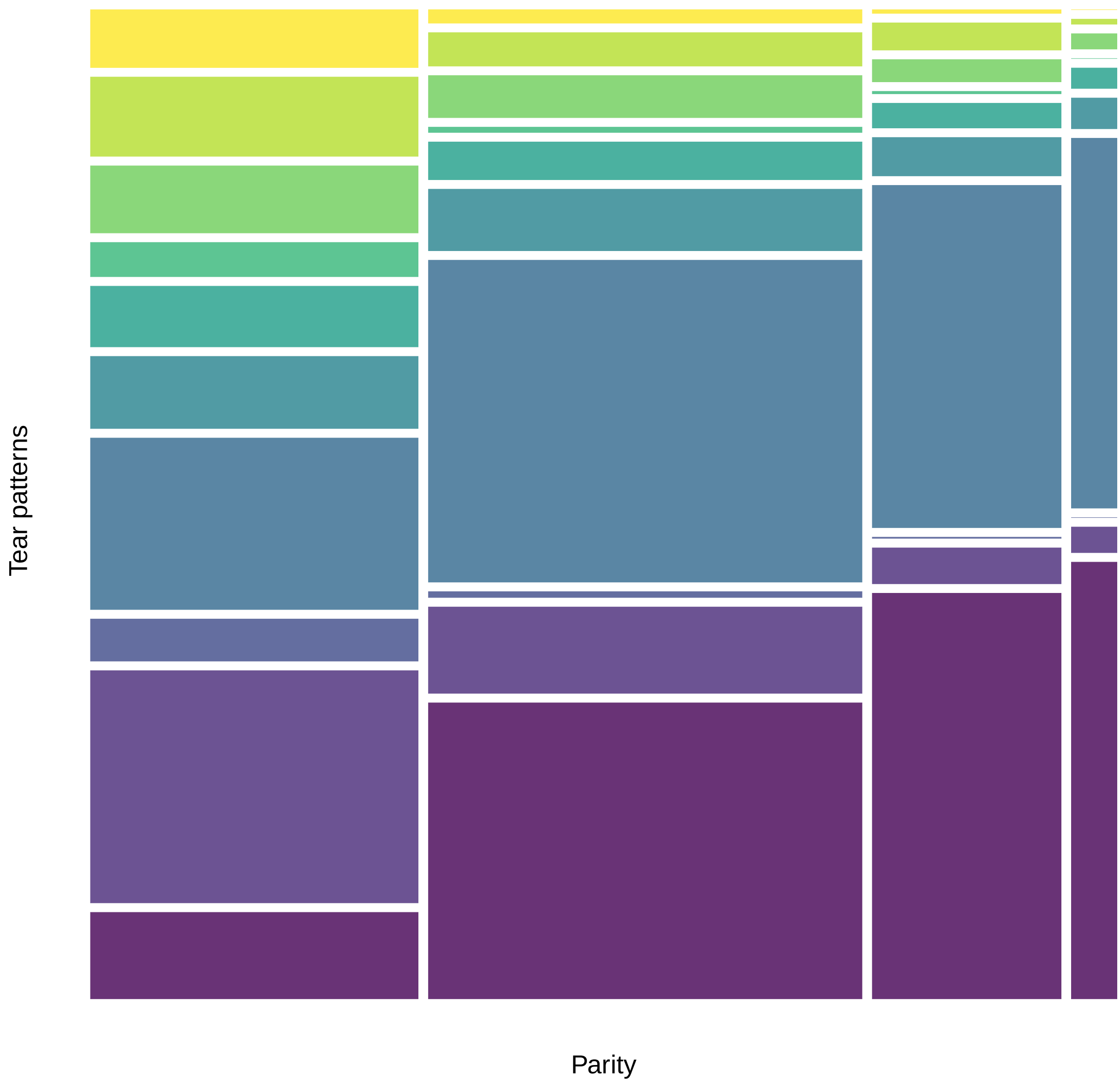

Figure 3: Frequency of ten most frequent tear patterns grouped by parity. The order of tear patterns on the Y-axis are ordered by the clinician.

Table 10: Frequency of 28 tear patterns by parity in ascending order. Each tear patterns is totaled per row. The number of tear patterns per parity are also recorded. This table is the same as 7 but in reversed order. This table was created to aid the interpretation of tile plots in Research question 2.

Tear pattern	1	2	3	4	Total
P3+4L	1	0	0	0	1
P3+4VL	1	0	0	0	1
P3+4PV	1	0	0	0	1
PVE	2	0	0	0	2
P3+4EV	4	1	0	0	5
EP	5	1	0	0	6
EVL	7	0	0	0	7
P3+4E	5	2	0	0	7
P3+4V	6	1	0	0	7
PL	4	4	1	0	9
PVL	7	3	0	0	10
P1+2LP	10	1	0	0	11
PV	8	4	0	0	12
P	5	5	3	1	14
P1+2PV	11	3	0	0	14
P3+4	9	7	3	0	19
EL	14	6	2	0	22
P1+2P	3	18	3	1	25
P1+2VL	48	10	2	0	60
EV	59	11	1	0	71
VL	81	25	3	0	109
P1+2L	85	70	20	4	179
V	94	78	18	3	193
L	111	62	22	1	196
P1+2V	101	114	31	6	252
E	325	160	29	5	519
I	121	548	327	85	1081
P1+2	240	596	276	72	1184
Total	1368	1730	741	178	4017

Table 11: Descriptive statistics of influencing factors by parity groups. For continuous factors, mean values with standard error in paranthesis are given. For categorical factors, absolute counts and percentages in paranthesis are given. If listed, the p-value corresponds to the between parity group differences and was calculated from a one-way F-test for continuous variables and chi-squared test for categorical variables at level 5%.

	1	2	3	4	p
n	1368	1730	741	178	
MaternalAge	28.39 (5.16)	30.68 (5.07)	31.96 (4.71)	33.77 (4.64)	<0.001
BMI	22.06 (3.52)	22.87 (4.18)	23.68 (4.24)	25.35 (5.17)	<0.001
Ethnicitycoded = 2	324 (24.9)	476 (28.8)	267 (37.2)	72 (41.9)	<0.001
GestationalAge	278.85 (8.13)	278.78 (7.45)	278.51 (7.61)	277.31 (8.24)	0.077
Birthmode					<0.001
Spon. Kristeller	21 (1.5)	14 (0.8)	5 (0.7)	0 (0.0)	
Spontaneous	1269 (92.8)	1667 (96.4)	730 (98.5)	178 (100.0)	
Vacuum	78 (5.7)	49 (2.8)	6 (0.8)	0 (0.0)	
Analgesia coded					<0.001
1	495 (87.5)	366 (54.7)	114 (40.3)	29 (41.4)	
2	65 (11.5)	278 (41.6)	156 (55.1)	39 (55.7)	
3	6 (1.1)	25 (3.7)	13 (4.6)	2 (2.9)	
Duration2ndstage	76.47 (53.83)	29.31 (37.51)	23.10 (30.98)	17.37 (22.48)	<0.001
Pushingduration	32.21 (22.74)	14.41 (14.23)	12.88 (15.09)	11.62 (11.18)	<0.001
Fetalposition					<0.001
DA_L	821 (60.0)	989 (57.2)	433 (58.4)	108 (60.7)	
DA_R	526 (38.5)	680 (39.3)	287 (38.7)	62 (34.8)	
DP_L	8 (0.6)	27 (1.6)	13 (1.8)	3 (1.7)	
DP_R	10 (0.7)	31 (1.8)	7 (0.9)	3 (1.7)	
FACE	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	
FOREHEAD	3 (0.2)	3 (0.2)	1 (0.1)	1 (0.6)	
Headcircumference	34.53 (1.27)	34.75 (1.25)	34.86 (1.18)	34.93 (1.35)	<0.001
Fetalweight	3360.09 (397.50)	3492.03 (424.01)	3524.91 (424.39)	3520.51 (475.61)	<0.001

with Kristeller, then Vacuum. The 2nd stage duration and pushing duration decrease with parity.

Maternal age, BMI, gestational age, 2nd stage duration, pushing duration, head circumference and fetal weight conditional means by parity are seen in Table 11 which is also reflected in their respective tile plots. The pushing phase and duration of 2nd stage decrease with increase parity as seen in Figure 8 and in Figure 7. Fetal weight seems to increase with increase parity as seen in Figure 11, which is consistent with the increasing BMI of the mother, an association observed by the clinician. In Figure 9, head circumference of each newborn in the study were graphed for each tear pattern trajectory with parity, the variations of these influencing factors are not marked. I assessed the continuous variable of head circumference in a spaghetti plot as well, and the variations were also not marked, as seen in Figure 10. It is also important to note the small counts of the tear patterns that occur at lower frequency for all the tile plots.

4.4 Research Question 3

Figure 12 and Figure 15 show a high proportion of P1+2 tear and Intact (or no tear) in parity 1. The figures are the same except that Y and X-axes reflect the descending order of tear patterns and

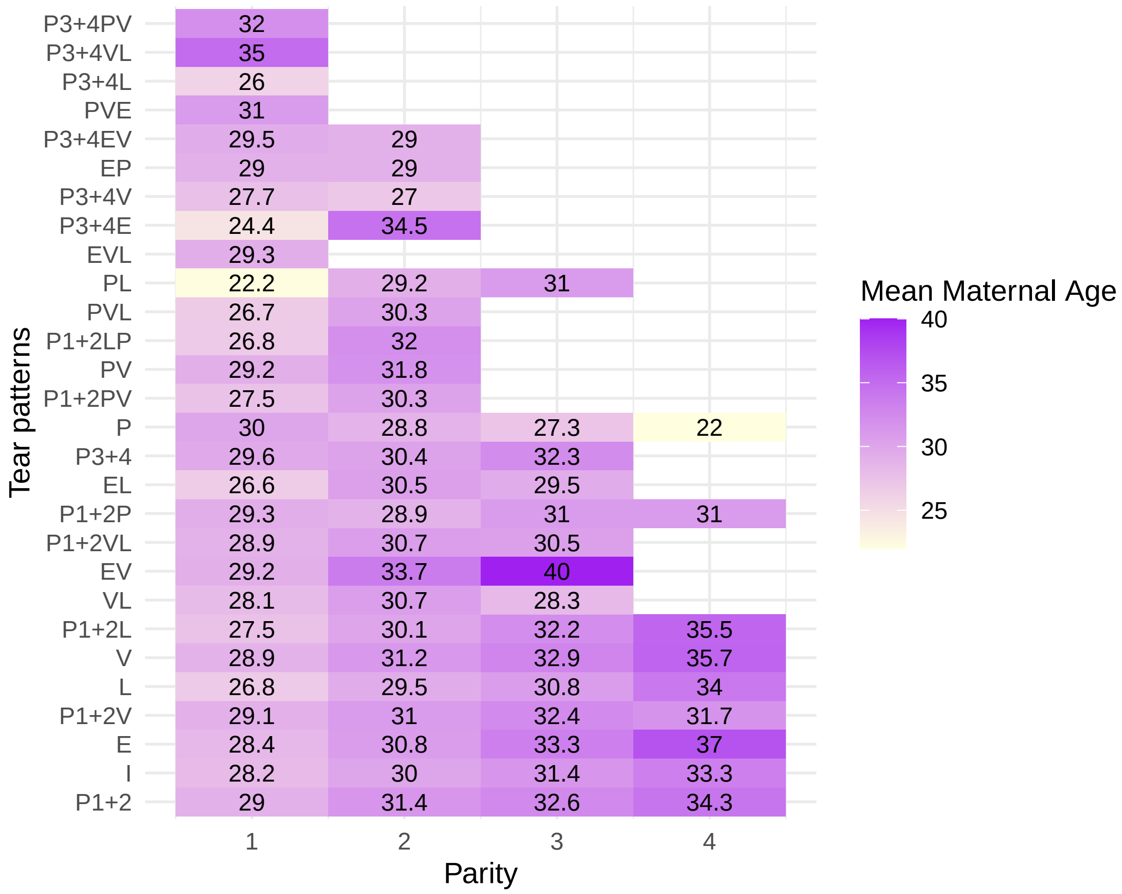

Figure 4: The conditional mean of maternal age across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable. The counts of the conditional variables are seen in Table 10.

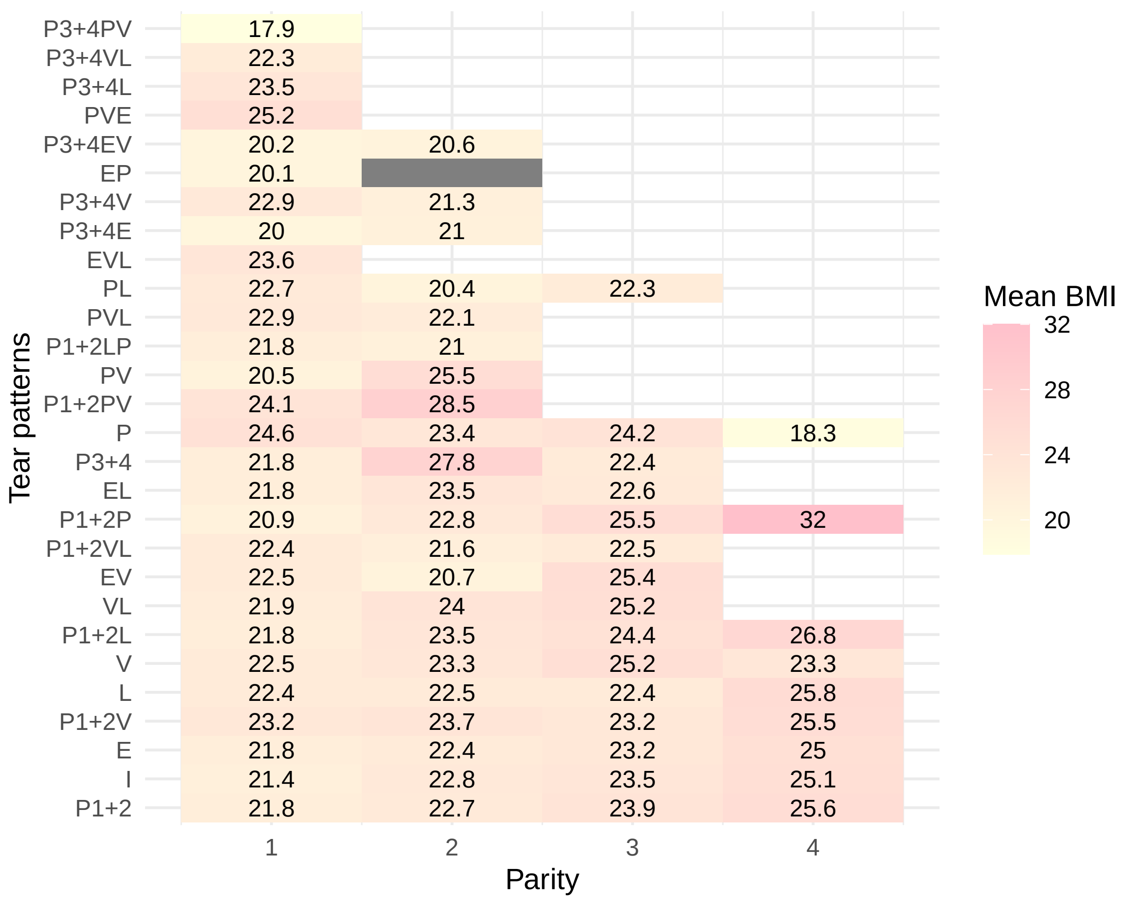

Figure 5: The conditional mean of BMI across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable. The counts of the conditional variables are seen in Table 10. The grey tile indicates no data for that particular conditional mean.

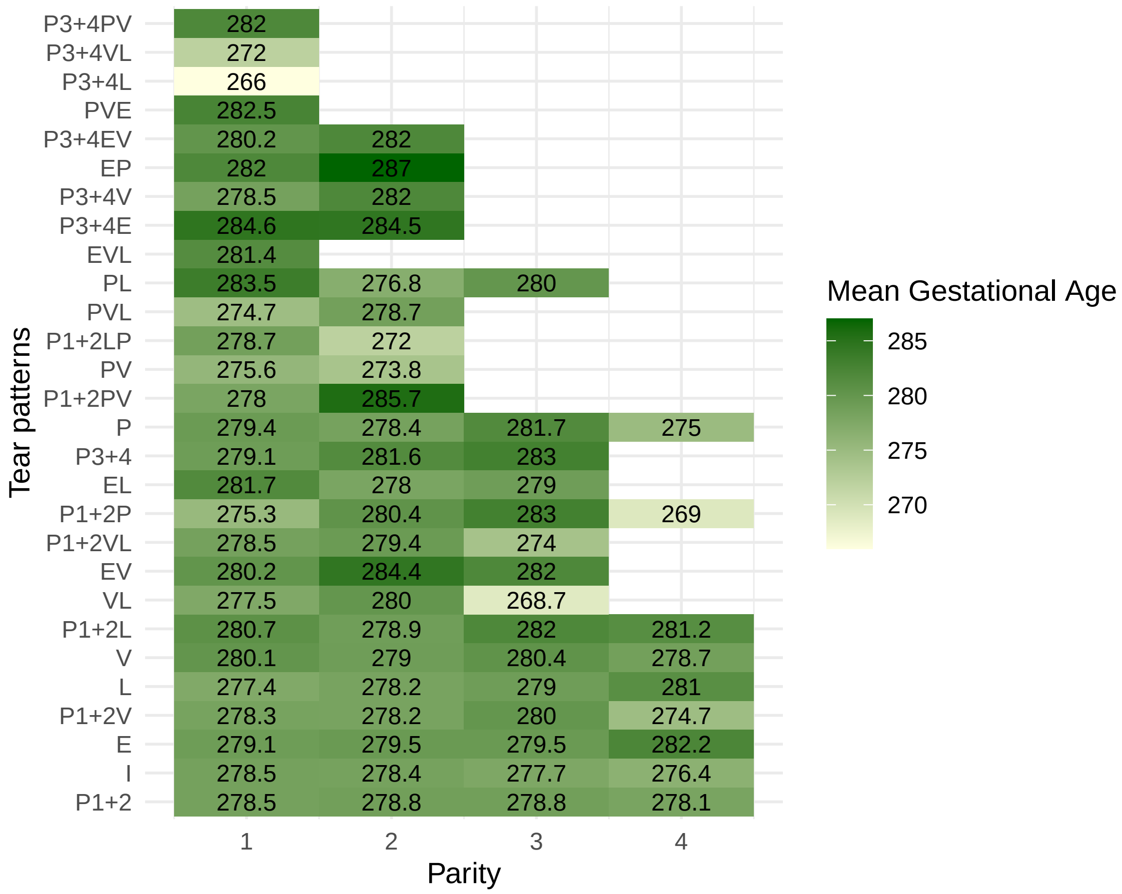

Figure 6: The conditional mean of gestational age across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable. The counts of the conditional variables are seen in Table 10.

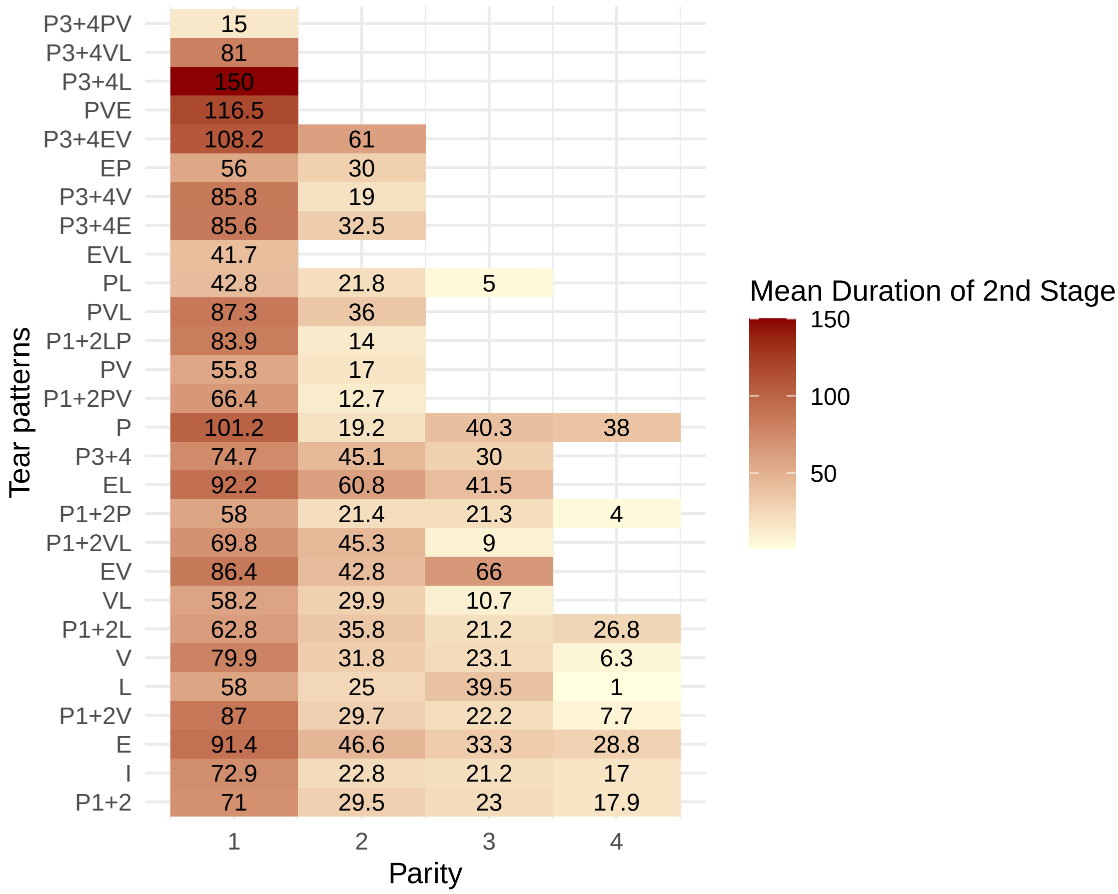

Figure 7: The conditional mean of 2nd stage duration across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable. The counts of the conditional variables are seen in Table 10.

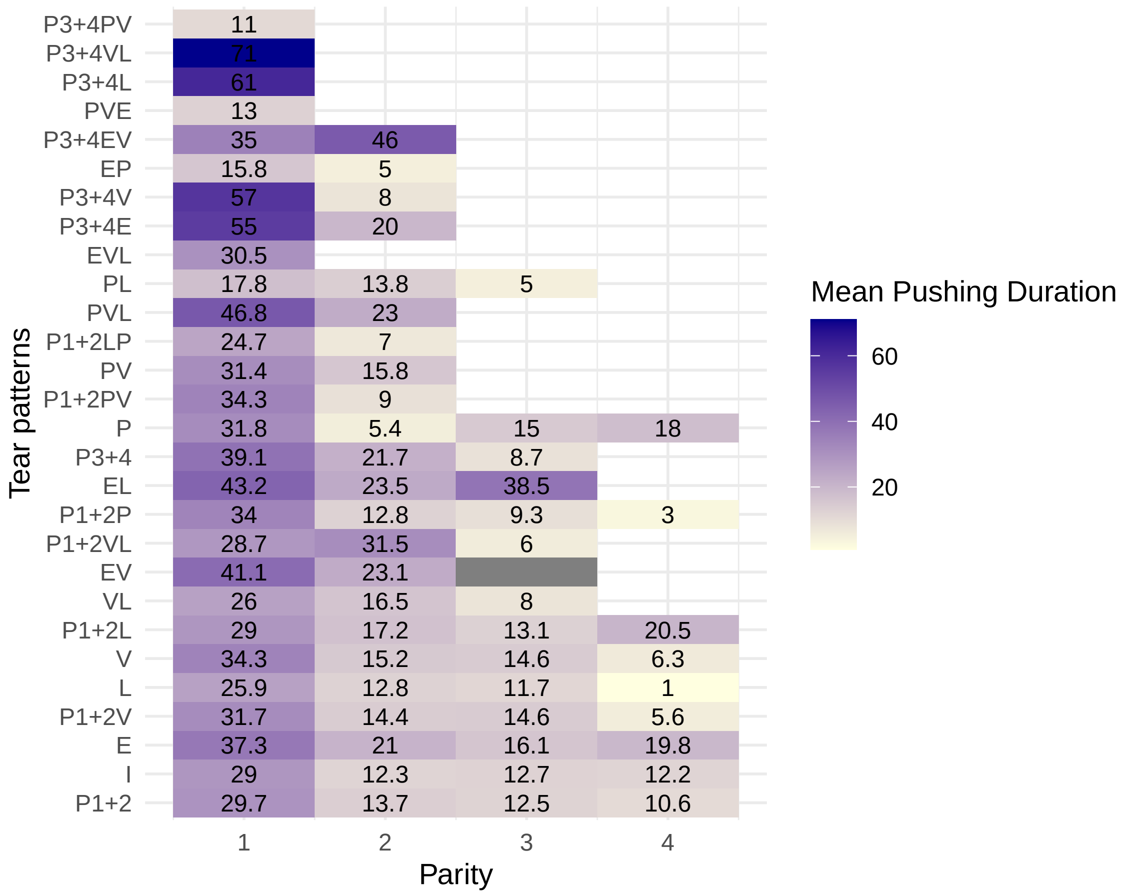

Figure 8: The conditional mean of pushing duration across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable. The counts of the conditional variables are seen in Table 10. The grey tile indicates no data for that particular conditional mean.

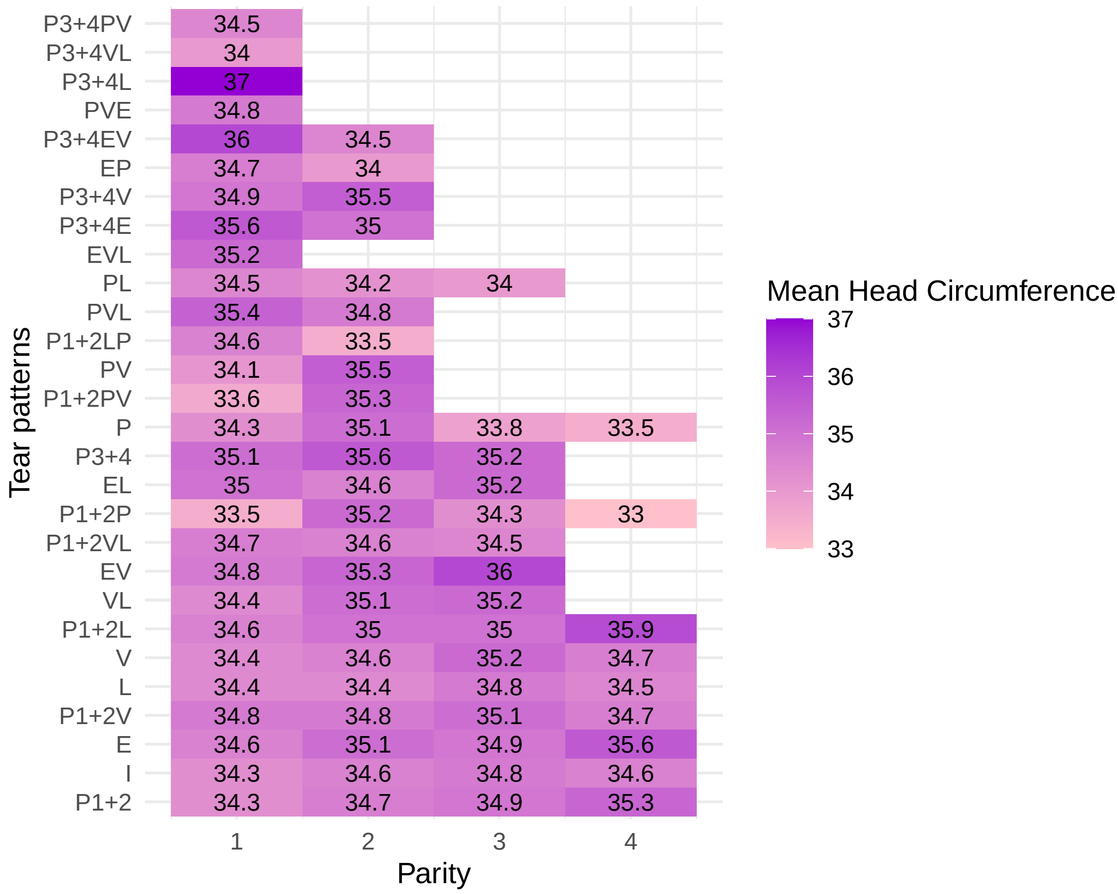

Figure 9: The conditional mean of head circumference across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable. The counts of the conditional variables are seen in Table 10.

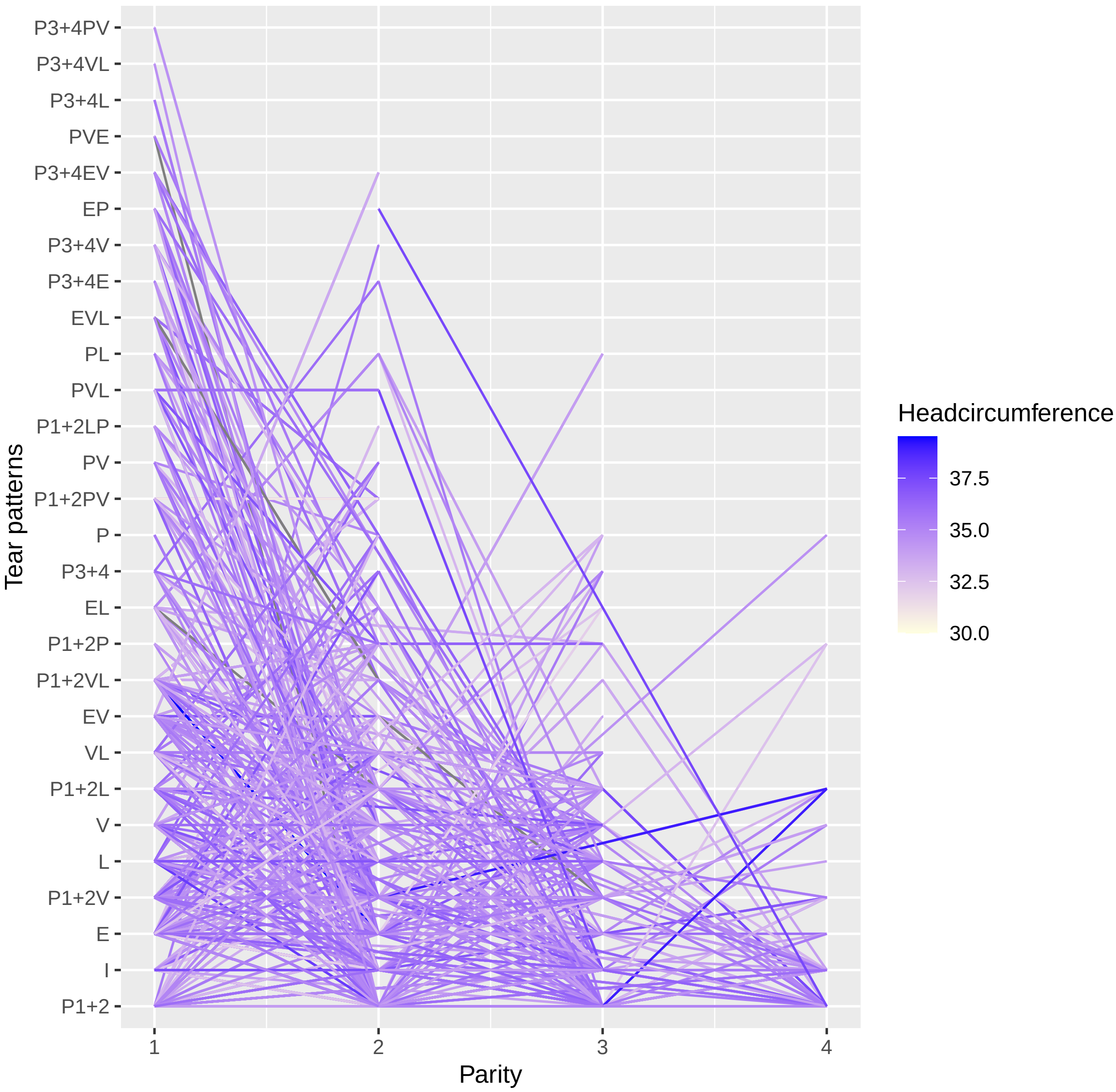

Figure 10: Trajectory of 1855 patients and head circumference outcome values for parity 1 to 4 across 28 tears patterns. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable.

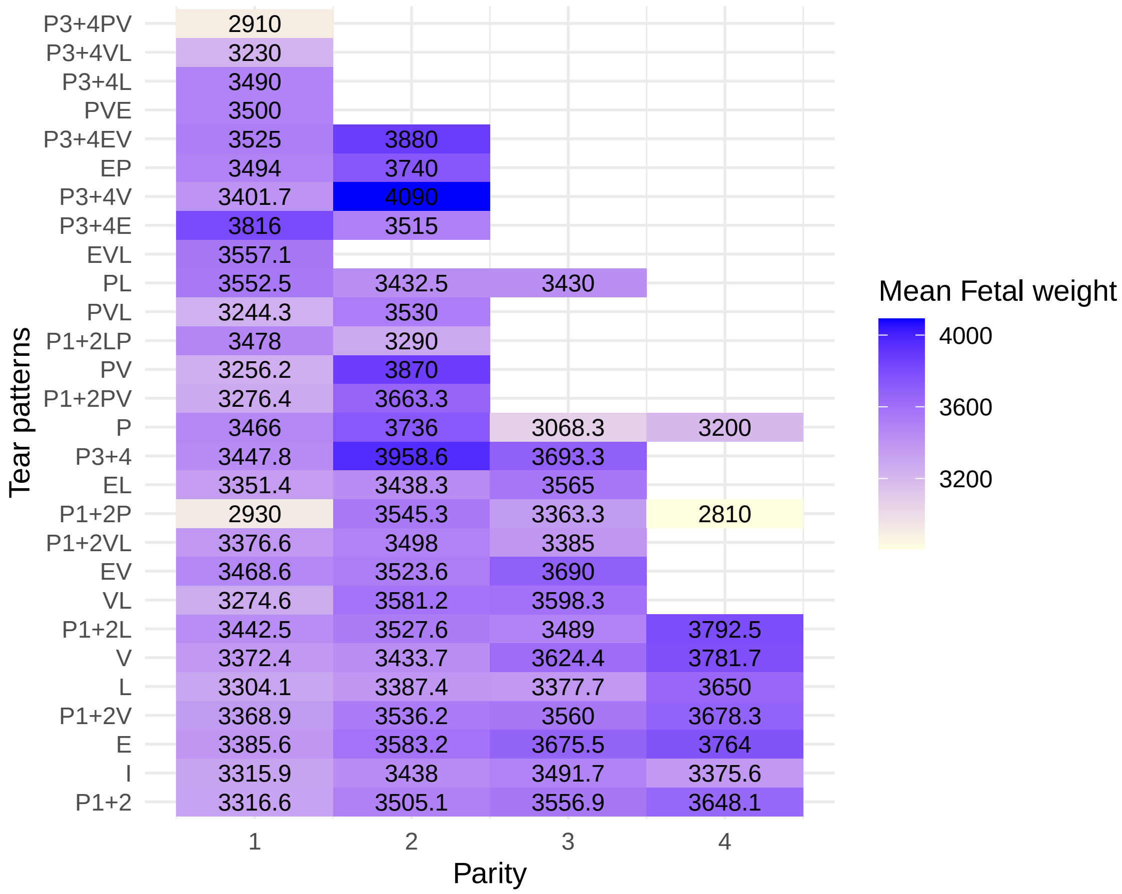

Figure 11: The conditional mean of fetal weight across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. Higher intensity of colour indicate higher values of the continuous variable. The counts of the conditional variables are seen in Table 10.

Table 12: Other outcome variables of APGARbelow7 (2 = No), pHNSAbelow7.15 (2 = No) by parity 1 to 4. The p-value corresponds to the between group differences and was calculated from a t-test. Values in the brackets are percentages. Note the counts of births decrease with increase parity.

	1	2	3	4	p
n	1368	1730	741	178	
pHNSAbelow7.15 = 2	1208 (94.0)	1557 (96.8)	681 (96.3)	169 (100.0)	<0.001
APGAR2below7 = 2	1356 (99.3)	1719 (99.6)	736 (99.6)	176 (100.0)	0.557

clinician's order respectively. A birth resulting in P1+2 tears in parity 1 tend to reflect a singular tear pattern "E" in parity 2, followed by no tear and P1+2V tear. A birth resulting in no tear in parity 1, tend to reflect varied results such as no tear and Labial tears of similar frequencies. An Episiotomy as a tear pattern occur in a low frequency in parity 1, however, reflect as the highest frequency in the subsequent birth.

For the subsequent births of parity 2 and 3 in Figure 13, a predisposition of no tear in parity 2, leads to a high proportion of no tear in parity 3 and a smaller proportion of P1+2 tear. The second most frequent tear is P1+2 in parity 2, which seems to have a high proportion of the same tear pattern in the subsequent parity of 3. Episiotomy occurs in small proportions in general but once there is a predisposition of it, the figure show they tend to appear again for the subsequent births as seen in Figure 13. The pattern for subsequent births of parity 2 and 3 seem to be repeated for the subsequent births of parity 3 and 4 as seen in Figure 14. Figure 14, Figure 17 reflect the same counts except the orders of tear patterns are respectively ascending and the clinician's order. This is also seen in Figure 13 and Figure 16.

5 Other outcome variables.

I have chosen to display a tile plot for blood loss per each of the 28 unique tear by parity 1 to 4 as seen in Figure 18. The variations of blood loss per tear across parities is not marked. In addition, APGARbelow7 and pHNSAbelow7.15 outcomes are seen in Table 12.

6 Conclusion

The frequency and distribution of tear pattern in births is a complex assessment to make. For Research Question 1 and 3, births of higher parity tend to have a higher proportion of "I" or no tears, even though counts of births decreases with increase in parity. P1+2 tears are most common and women who are predisposed to these tears tend to repeat them in subsequent parity and or have no tears. For Research Question 2, many influencing factors were assessed by parity. A common trend cannot be determined for any particular tear pattern and furthermore, there are smaller counts of the conditional means of higher parities and for less frequent tear patterns. Thus a limitation of this study is the low birth counts for these outcomes. In addition, whether grouping perineal tear of grade 1 and 2 and likewise grade 3 and 4, has the same clinical implications to a woman, may benefit from further study. However, a start on how one can understand the frequency and distribution of tear patterns has been created in a manner clinicians have not yet seen in the literature.

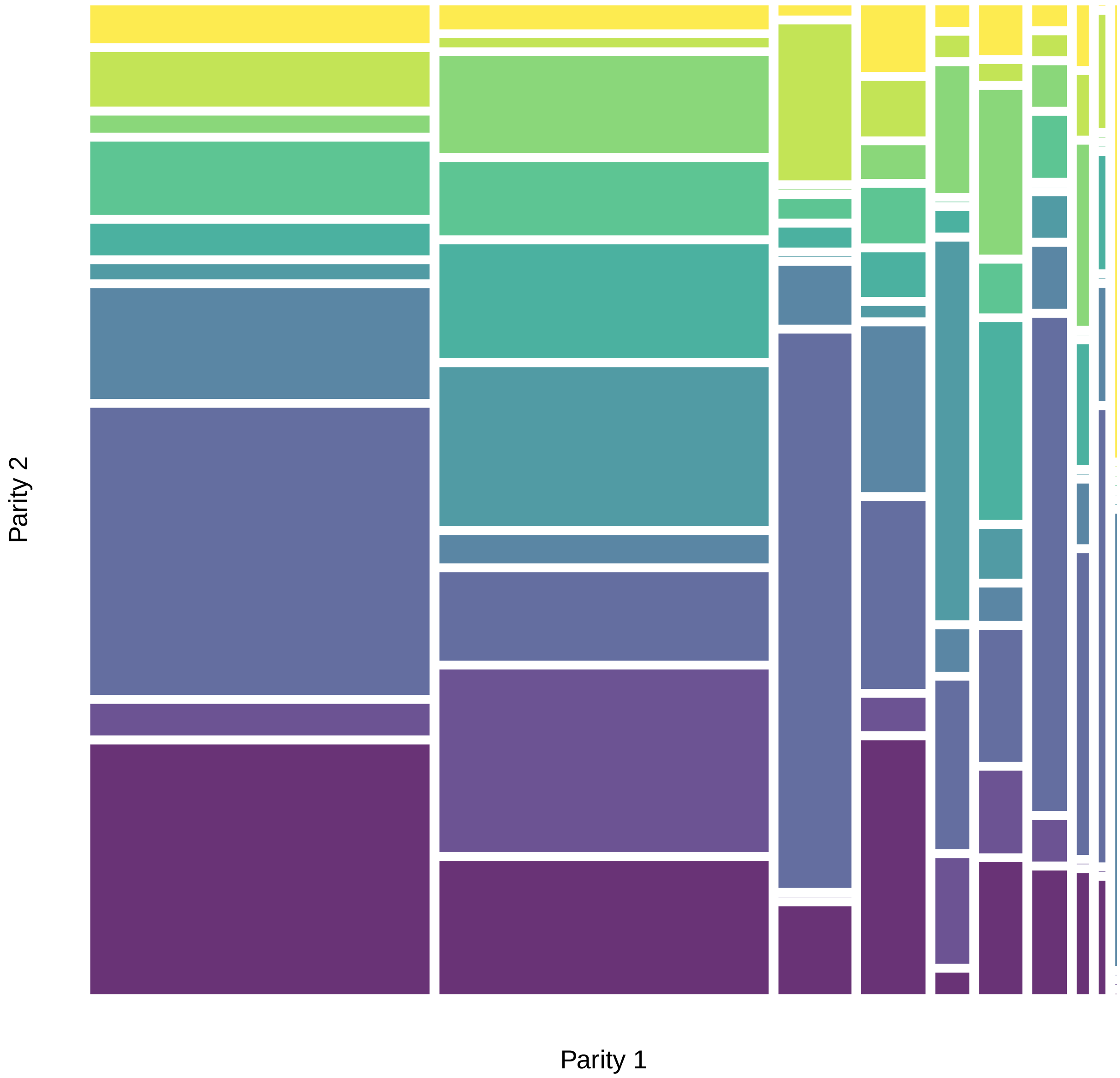

Figure 12: Ten most frequent tear patterns in subsequent births of parity 1 and 2. X and Y-axis tear patterns are ordered in aescending order by ten most frequent tear patterns from parity 1 to 4, as in Table 9. The counts of this subsequent births are seen in the descriptive statistics.

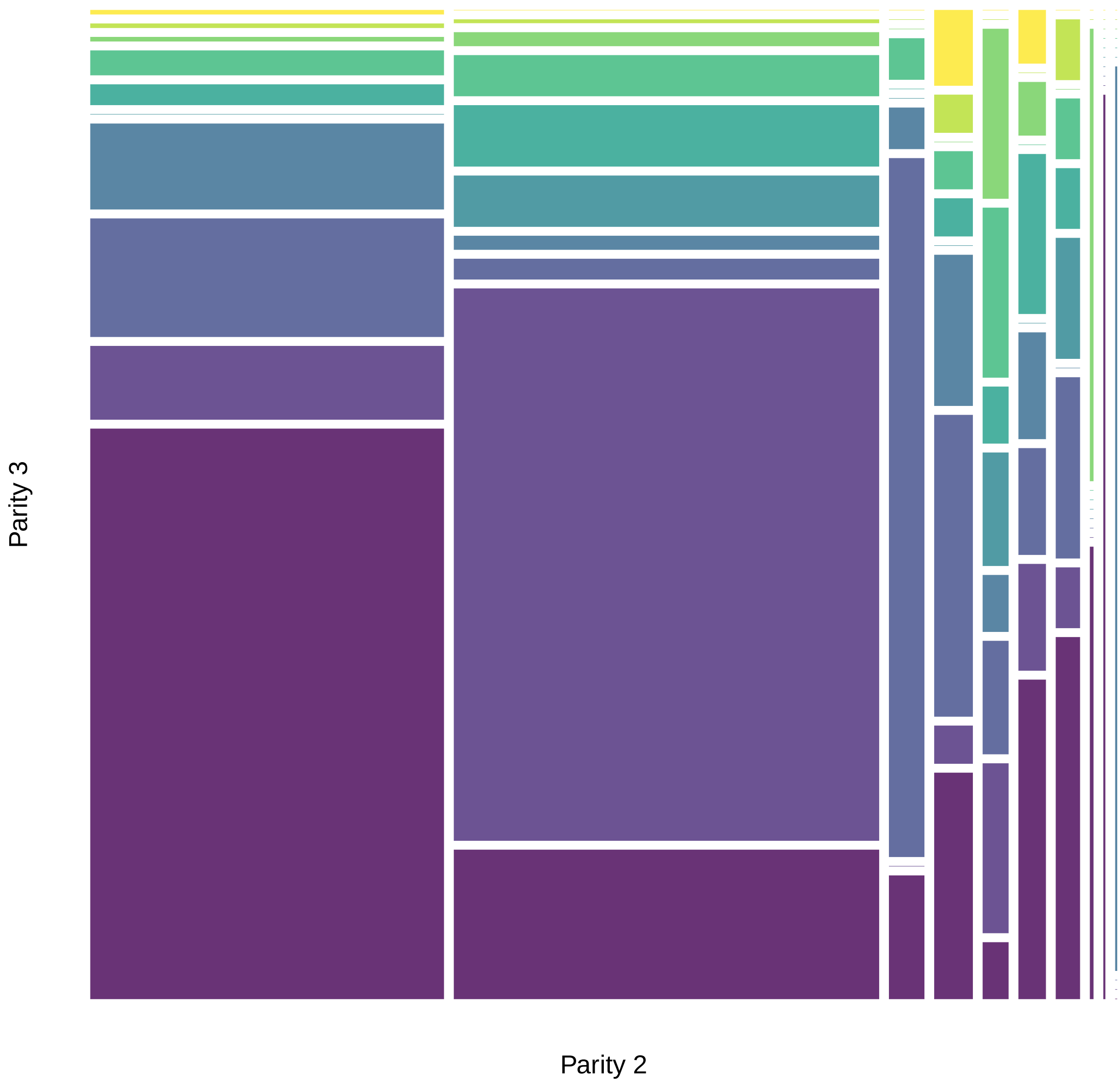

Figure 13: Ten most frequent tear patterns in subsequent births of parity 2 and 3. X and Y-axis tear patterns are ordered in ascending order by ten most frequent tear patterns from parity 1 to 4, as in Table 9. The counts of this subsequent births are seen in the descriptive statistics.

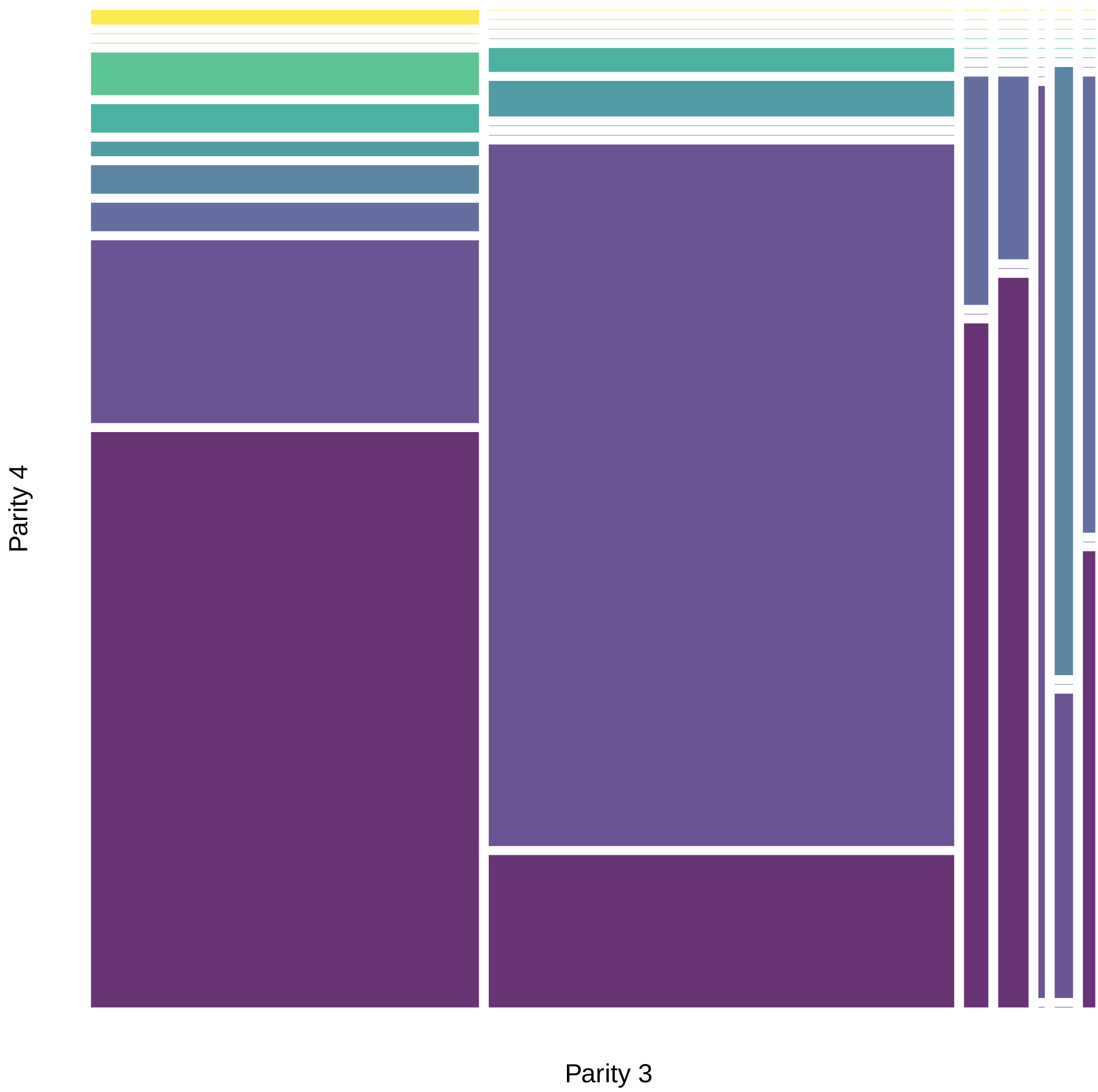

Figure 14: Ten most frequent tear patterns in subsequent births of parity 3 and 4. X and Y-axis tear patterns are ordered in aescending order by ten most frequent tear patterns from parity 1 to 4, as in Table 9. The counts of this subsequent births are seen in the descriptive statistics.

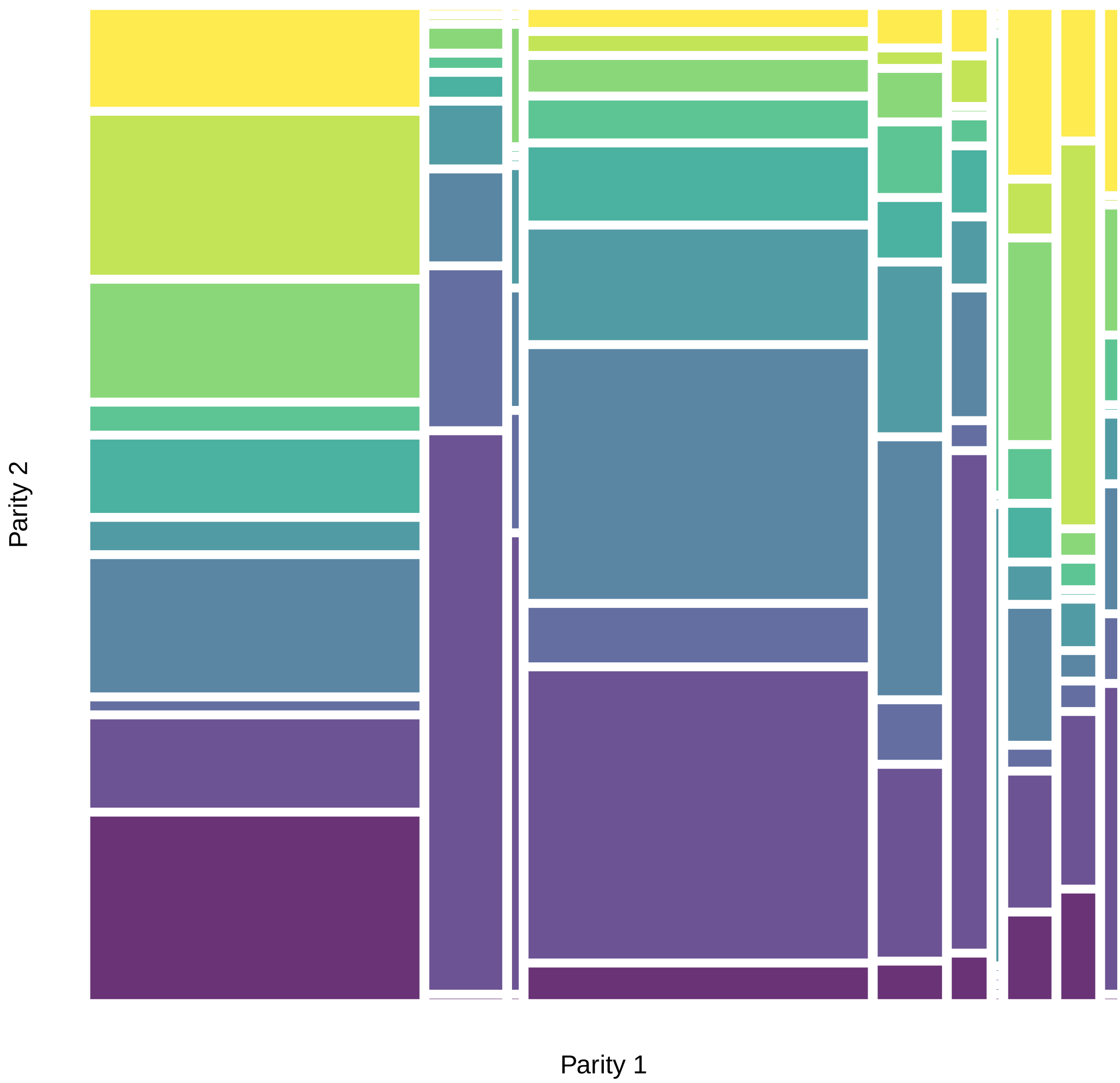

Figure 15: Ten most frequent tear patterns in subsequent births of parity 1 and 2. X and Y-axis tear patterns are ordered by the clinician. The counts of this subsequent births are seen in the descriptive statistics.

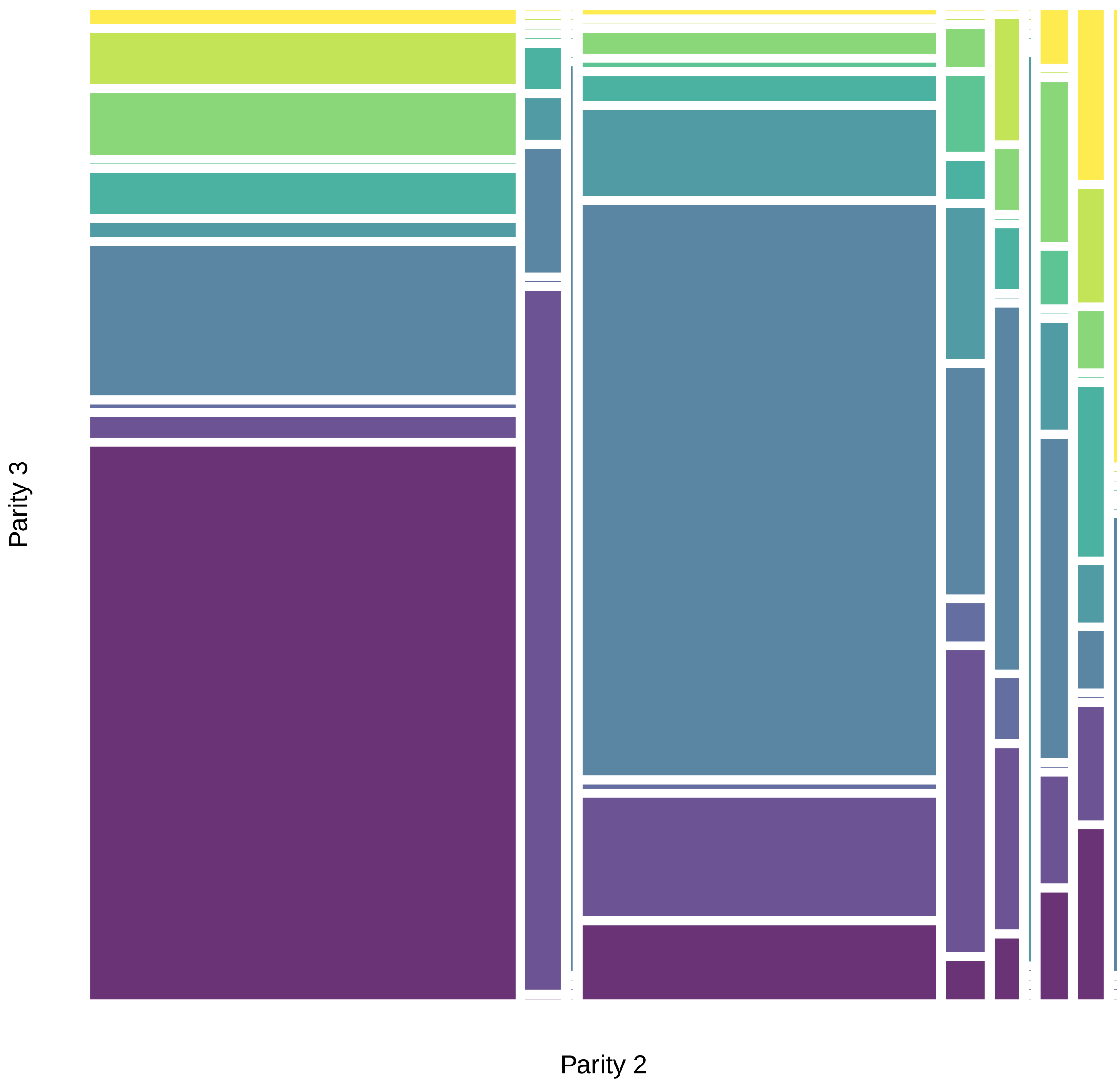

Figure 16: Ten most frequent tear patterns in subsequent births of parity 2 and 3. X and Y-axis tear patterns are ordered by the clinician. The counts of this subsequent births are seen in the descriptive statistics.

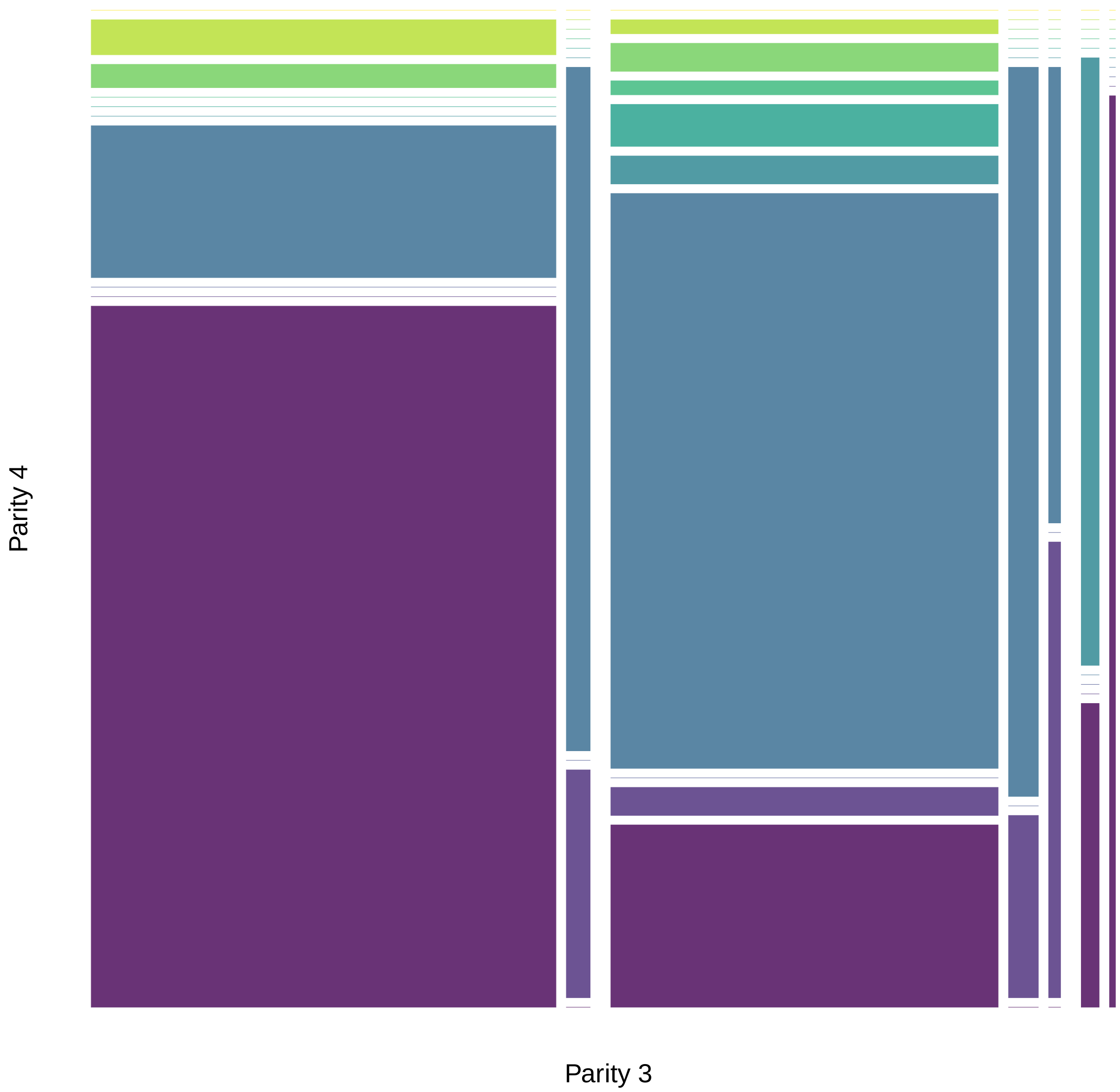

Figure 17: Ten most frequent tear patterns in subsequent births of parity 3 and 4. X and Y-axis tear patterns are ordered by the clinician. The counts of this subsequent births are seen in the descriptive statistics.

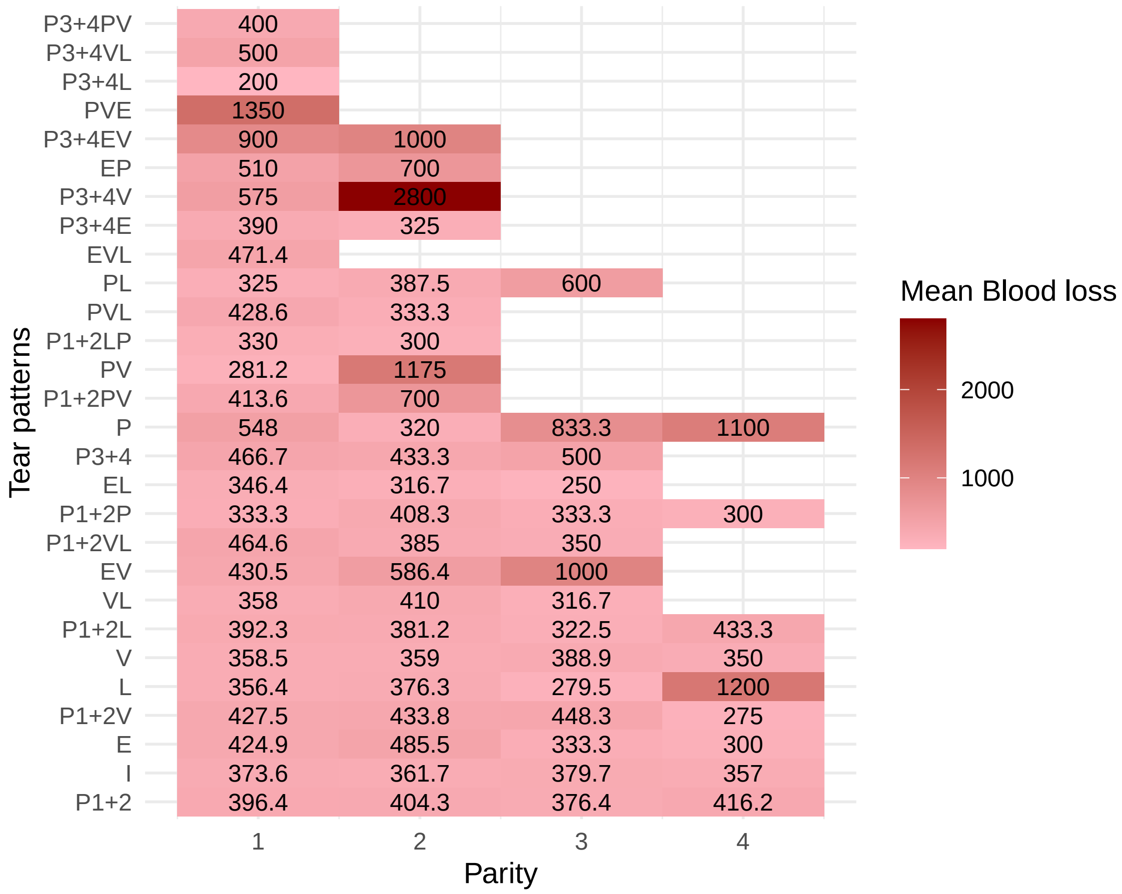

Figure 18: The conditional mean blood loss in mL across parity 1 to 4. The tear patterns are ordered by aggregated frequency from parity 1 to 4. The tear patterns are ordered from most infrequent on the top of the Y-axis. The counts of the conditional variables are seen in Table 10.

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Zhu, H. (2019). *kableExtra: Construct Complex Table with 'kable' and Pipe Syntax.* R package version 1.1.0.
URL https://CRAN.R-project.org/package=kableExtra

R version and packages used to generate this report:

R version: R version 4.0.3 (2020-10-10)

Base packages: stats, graphics, grDevices, utils, datasets, methods, base

Other packages: RColorBrewer 1.1-2, kableExtra 1.3.1, viridis 0.5.1, viridisLite 0.4.0, janitor 2.1.0, ggmosaic 0.2.0, forcats 0.5.0, stringr 1.4.0, dplyr 1.0.3, purrr 0.3.4, readr 1.4.0, tidyr 1.1.2, tibble 3.1.1, ggplot2 3.3.5, tidyverse 1.3.0, readxl 1.3.1, tableone 0.12.0, knitr 1.36

This document was generated on December 18, 2021 at 14:22.

7 Appendix

```
################################################
####### code for packages, settings, data prep
################################################
library(tableone)
library(readxl)
library(tidyverse)
library(dplyr)
library(ggmosaic)
library(janitor)
library(viridis)
library(kableExtra)
library(RColorBrewer)

## Additional settings
cols <- brewer.pal(3, "Set1")
options(width = 85, digits = 4, show.signif.stars=FALSE)
alpha <- 0.05
qa <- qnorm(1 - alpha / 2)

## Import Data
tab <- read_excel("../data/Datensatz29.04.2019.xlsx")

## Data Preparation
tab %>%
  mutate(Tear1_code = case_when(
     Tear1 == "Damm intakt" ~ "I",
     Tear1 == "Labienriss" ~ "L",
     Tear1 == "Vaginalriss" ~ "V",
     Tear1 == "Paraklitoralriss" ~ "P",
     Tear1 == "Dammriss I+II" ~ "P1+2",
     Tear1 == "Dammriss III/V" ~ "P3+4",
     Tear1 == "Epi. mediolateral" ~ "E")) %>%
  mutate(Tear2_code = case_when(
     Tear2 == "Damm intakt" ~ "I",
     Tear2 == "Labienriss" ~ "L",
     Tear2 == "Vaginalriss" ~ "V",
     Tear2 == "Paraklitoralriss" ~ "P",
     Tear2 == "Dammriss I+II" ~ "P1+2",
     Tear2 == "Dammriss III/V" ~ "P3+4",
     Tear2 == "Epi. mediolateral" ~ "E")) %>%
  mutate(Tear3_code = case_when(
     Tear3 == "Damm intakt" ~ "I",
     Tear3 == "Labienriss" ~ "L",
     Tear3 == "Vaginalriss" ~ "V",
     Tear3 == "Paraklitoralriss" ~ "P",
     Tear3 == "Dammriss I+II" ~ "P1+2",
     Tear3 == "Dammriss III/V" ~ "P3+4",
     Tear3 == "Epi. mediolateral" ~ "E")) %>%
  mutate(Fetalposition = case_when(
    #we change fetal position descriptions into codes which are anatomically based
    Fetalposition == "KINDLAGE01" ~ "DA_L",
    Fetalposition == "KINDLAGE02" ~ "DA_R",
    Fetalposition == "KINDLAGE03" ~ "DP_L",
    Fetalposition == "KINDLAGE04" ~ "DP_R",
    Fetalposition == "KINDLAGE09" ~ "FACE",
```

```
    Fetalposition == "KINDLAGE17" ~ "FOREHEAD" )) %>%
  mutate(CTG = case_when(
    CTG == "CTGFETAL01" ~ "Physiol",
    CTG == "CTGFETAL02" ~ "Suspic",
    CTG == "CTGFETAL03" ~ "Path" )) %>%
  mutate(Birthmode = case_when(
    Birthmode == "GEBMODUS01" ~ "Spontaneous",
    Birthmode == "GEBMODUS02" ~ "Spon. Kristeller",
    Birthmode == "GEBMODUS04" ~ "Vacuum" )) -> tab_code1_11
tab_code1_11 %>%
  rename(ID = ZASID)  -> tab_code1_11

# make sure that each women has at least two births
uniqueIDs<-unique(tab_code1_11$ID)
lengthsperID<-numeric(0)
for (i in 1:length(uniqueIDs)) lengthsperID<-c(lengthsperID,dim(tab_code1_11[tab_code1_11$ID==uniqueIDs[i],1])[1])
sum(lengthsperID==1)
# 7 IDs appear only once: have to be removed
dim(tab_code1_11)
tab_code1_11 %>%
  filter(!ID %in% uniqueIDs[lengthsperID==1]) -> tab_code1_11
dim(tab_code1_11)

# Remove parity five and higher births,
# making sure that there are at least
# two births per women after removing
tab_code1_11 %>%
  filter(Parity >= 5) -> tab5
dim(tab5)
tab_code1_11 %>%
  filter(Parity <= 4) -> tab4
par5ids <- unique(tab5$ID)
length(par5ids)  #60 unique IDs in Par 5 and above
par5nosbirth<-numeric(0)
for (i in 1:length(par5ids))
{par5nosbirth[i] <- dim(tab4[tab4$ID==par5ids[i],1])[1]}
#number of IDs in Par5 that appear in the data of parity 4 and below
#which shows number of other births these parity 5 women have
sum(par5nosbirth==1)
# 25 = number of women for which there is a birth in par >= 5  and only one more in par <=4
idstoremove<-par5ids[par5nosbirth==1]
# 25 IDs to remove are the IDs that have 1 birth in par <=4
# of the Par 5 group.
tab_code1_11 %>%
  filter(!ID %in% idstoremove) -> tab_code1_11_transition
tab_code1_11_transition %>%
  filter(Parity<5) -> tab_code
# now all in the tab_code are women who have at least 2 births in the
#study population, excluding those of Parity 5 and above.

# now all in the tab_code are women who have at least 2 births in the
#study population, excluding those of Parity 5 and above.

## concatenate tear patterns
tab_code %>%
  mutate(Tear1_code = factor(Tear1_code,
                             levels=c("I","E","P1+2","P3+4","V","L","P"), ordered=TRUE)) %>%
```

```
  mutate(Tear2_code = factor(Tear2_code,
                             levels=c("I","E","P1+2","P3+4","V","L","P"), ordered=TRUE)) %>%
mutate(Tear3_code = factor(Tear3_code,
                           levels=c("I","E","P1+2","P3+4","V","L","P"), ordered=TRUE)) -> tab_code
sorttear_pattern <- function(vec){ paste(sort(vec), collapse ="") }

tab_code$tear_pattern<-apply(tab_code[,23:25],1,sorttear_pattern)

tab_code %>%
  mutate(tab_code$tear_pattern) -> tab_code # We add tear_pattern to the main data frame
(whichtear_pattern<-unique(tab_code$tear_pattern)) #what are the 28 different tear_pattern
(nooftear_pattern<-sort(table(tab_code$tear_pattern),decreasing=TRUE)) #count them

# renaming tear patterns
tab_code %>%
  mutate(tear_pattern = case_when(
    tear_pattern == "P1+2" ~ "P1+2",
    tear_pattern == "I" ~ "I",
    tear_pattern == "E" ~ "E",
    tear_pattern == "P1+2V" ~ "P1+2V",
    tear_pattern == "L" ~ "L",
    tear_pattern == "V" ~ "V",
    tear_pattern == "LP1+2" ~ "P1+2L",
    tear_pattern == "LV" ~ "VL",
    tear_pattern == "EV" ~ "EV",
    tear_pattern == "LP1+2V" ~ "P1+2VL",
    tear_pattern == "PP1+2" ~ "P1+2P",
    tear_pattern == "EL" ~ "EL",
    tear_pattern == "P3+4" ~ "P3+4",
    tear_pattern == "P" ~ "P",
    tear_pattern == "PP1+2V" ~ "P1+2PV",
    tear_pattern == "PV" ~ "PV",
    tear_pattern == "LPP1+2" ~ "P1+2LP",
    tear_pattern == "LPV" ~ "PVL",
    tear_pattern == "LP" ~ "PL",
    tear_pattern == "ELV" ~ "EVL",
    tear_pattern == "EP3+4" ~ "P3+4E",
    tear_pattern == "P3+4V" ~ "P3+4V",
    tear_pattern == "EP" ~ "EP",
    tear_pattern == "EP3+4V" ~ "P3+4EV",
    tear_pattern == "EPV" ~ "PVE",
    tear_pattern == "LP3+4" ~ "P3+4L",
    tear_pattern == "LP3+4V" ~ "P3+4VL",
    tear_pattern == "PP3+4V" ~ "P3+4PV")) -> tab_code

## Final Dataset
tab_code$tear_pattern = factor(tab_code$tear_pattern,
                               levels=c("P1+2", "I", "E", "P1+2V", "L", "V", "P1+2L", "VL", "EV",
                                        "P1+2VL", "P1+2P", "EL", "P3+4", "P", "P1+2PV", "PV",
                                        "P1+2LP", "PVL", "PL", "EVL", "P3+4E", "P3+4V", "EP",
                                        "P3+4EV", "PVE", "P3+4L", "P3+4VL", "P3+4PV"),
                               ordered=TRUE)
#Audrey's data set for top 10 tear patterns
tab_code %>%
  tabyl(tear_pattern, Parity) %>%
  adorn_totals(where ="col") %>%
   arrange(desc(Total)) %>%
```

```
  adorn_totals(where = c("row")) %>%
  rename("Tear pattern" = "tear_pattern") -> t_t28

tab_code %>%
  tabyl(tear_pattern, Parity) %>%
  adorn_totals(where ="col") %>%
  arrange((Total)) %>%
  adorn_totals(where = c("row")) %>%
  rename("Tear pattern" = "tear_pattern") -> t_t28_reverse

stat10 <- c("P1+2", "I", "E", "P1+2V", "L", "V", "P1+2L", "VL", "EV", "P1+2VL")

tab_code %>%
  filter(tear_pattern %in% stat10) %>%
  tabyl(tear_pattern, Parity) %>%
  adorn_totals(where ="col") %>%
  adorn_totals(where = c("row")) %>%
  filter(!`1` == 0) %>%
  rename("Tear pattern" = "tear_pattern") -> t_t10

tab_code %>%
  filter(tear_pattern %in% stat10) %>%
  tabyl(tear_pattern, Parity) %>%
  adorn_totals(where ="col") %>%
  adorn_totals(where = c("row")) %>%
  filter(!`1` == 0) %>%
  arrange((Total)) %>%
  rename("Tear pattern" = "tear_pattern") -> t_t10_reverse

stat28 <- t_t28$`Tear pattern`
#Nina's top 10 tear patterns
nina10 <- c("I", "E", "EV", "P1+2", "P1+2V", "P1+2L", "P1+2VL", "V", "L", "VL")

tab_code %>%
  filter(tear_pattern %in% stat10) %>%
  as.data.frame() -> tab_code_top10tear_pattern

tab_code %>%
  select(ID, Parity, tear_pattern) %>%
  filter(tear_pattern %in% stat10) -> tab_concode
tab_concode$tear_pattern <-  factor(tab_concode$tear_pattern, levels=stat10, ordered=TRUE)

tab_concode %>%
  filter(Parity==1) %>%
  select(ID, tear_pattern, Parity) -> tab_concodepar1

tab_concode %>%
  filter(Parity==2) %>%
 select(ID, tear_pattern, Parity) -> tab_concodepar2

inner_join(tab_concodepar1, tab_concodepar2, by="ID") -> tab_concodepar12
nrow(tab_concodepar12) #1199

tab_concodepar12 %>%
  count() -> par12counts

tab_concodepar12 %>%
```

```
  rename("tear_patternP1" = "tear_pattern.x") -> tab_concodepar12
tab_concodepar12 %>%
  rename("tear_patternP2" = "tear_pattern.y") -> tab_concodepar12
tab_concodepar12 %>%
  select (-c("Parity.x", "Parity.y"))-> tab_concodepar12


tab_concode %>%
  filter(Parity==3) %>%
 select(ID, tear_pattern, Parity) -> tab_concodepar3
inner_join(tab_concodepar2, tab_concodepar3, by="ID") -> tab_concodepar23

tab_concodepar23 %>%
  count() -> par23counts

tab_concodepar23 %>%
  rename("tear_patternP2" = "tear_pattern.x") -> tab_concodepar23
tab_concodepar23 %>%
  rename("tear_patternP3" = "tear_pattern.y")  -> tab_concodepar23
tab_concodepar23 %>%
  select (-c("Parity.x", "Parity.y"))-> tab_concodepar23

tab_concode %>%
  filter(Parity==4) %>%
 select(ID, tear_pattern, Parity) -> tab_concodepar4
inner_join(tab_concodepar3, tab_concodepar4, by="ID") -> tab_concodepar34

tab_concodepar34 %>%
  count() -> par34counts

tab_concodepar34 %>%
  rename("tear_patternP3" = "tear_pattern.x")  -> tab_concodepar34
tab_concodepar34 %>%
  rename("tear_patternP4" = "tear_pattern.y")  -> tab_concodepar34
tab_concodepar34 %>%
  select (-c("Parity.x", "Parity.y"))-> tab_concodepar34
inner_join(tab_concodepar12, tab_concodepar3, by= "ID") -> tab_concodepar123

tab_concodepar123 %>%
  count() -> par123counts

inner_join(tab_concodepar12, tab_concodepar34, by="ID") -> tab_concodepar1234

tab_concodepar1234 %>%
  count() -> par1234counts

tab_code %>%
  group_by(ID) %>%
  dplyr::count(Parity)


##################################################
####### code for descriptive statistics
##################################################
tab_code1_11 %>%
  tabyl(Parity) %>%
  adorn_totals( where = "row") %>%
```

```
  adorn_rounding(digits=3) %>%
  select(-c(percent)) -> tab_par1_11
knitr::kable(tab_par1_11, booktabs = TRUE, format = "latex", row.names = FALSE)
tab_code %>%
  tabyl(Parity) %>%
  adorn_totals( where = "row") %>%
  adorn_rounding(digits=3) %>%
  select(-c(percent)) -> tab_par1_4
knitr::kable(tab_par1_4, row.names = FALSE, booktabs = TRUE, format = "latex")
tab_code_long %>%
  tabyl(Tear_code, Parity) %>%
  adorn_totals(where ="col") %>%
  arrange(desc(Total)) %>%
  adorn_totals(where = c("row")) %>%
  rename("Tear code" = "Tear_code") -> tcl_freq
knitr::kable(tcl_freq, booktabs = TRUE, format = "latex", row.names = FALSE)
knitr::kable(t_t28, row.names = FALSE, booktabs = TRUE, format = "latex")
knitr::kable(t_t10, row.names = FALSE, booktabs = TRUE, format = "latex")

#################################################
####### code for results: research question 1
#################################################
tcl_freq %>%
  arrange(Total) -> tcl_freq_reversed
knitr::kable(tcl_freq_reversed, row.names = FALSE, booktabs = TRUE, format = "latex")
tcl_freq %>%
  select(-Total) %>%
  slice(1:7) -> tcl_freq_naked
Seventear_codes <- tcl_freq_naked$`Tear code`
Seventear_codes <- factor(tcl_freq_naked$`Tear code`, levels = Seventear_codes, order = TRUE)
tab_code_long$Tear_code_ordered <- factor(tab_code_long$Tear_code, levels = Seventear_codes, order = TRUE)
tab_code_long %>%
  ggplot() +
  geom_mosaic(aes(x = product(Tear_code_ordered, Parity), fill = Tear_code_ordered)) +
  theme_minimal() +
  labs(x = "Parity", y = "Tear values", title= "") +
  theme(
    legend.position = "",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> tcl_mosaic
tcl_mosaic
knitr::kable(t_t10_reverse, row.names = FALSE, booktabs = TRUE, format="latex")
tab_code_top10tear_pattern$tear_pattern_ordered <- factor(tab_code_top10tear_pattern$tear_pattern, levels=stat10, o
tab_code_top10tear_pattern %>%
  ggplot() +
  geom_mosaic(aes(x = product(tear_pattern_ordered, Parity), fill = tear_pattern_ordered)) +
  theme_minimal() +
  labs(x = "Parity", y = "") +
  ggtitle("") +
  theme(
    legend.position = "none",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank())  -> mosaic_top10tear_pattern
mosaic_top10tear_pattern
tab_code_top10tear_pattern$nina10_ordered <- factor(tab_code_top10tear_pattern$tear_pattern, levels=nina10, ordered
tab_code_top10tear_pattern %>%
  ggplot() +
```

```
  geom_mosaic(aes(x = product(nina10_ordered , Parity), fill = nina10_ordered )) +
  theme_minimal() +
  labs(x = "Parity", y = " Tear patterns", title = "") +
  theme(
    legend.position = "none",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> mosaic_top10tear_patternnina
mosaic_top10tear_patternnina
knitr::kable(t_t28_reverse, booktabs = TRUE, format = "latex", row.names = FALSE)

##################################################
####### code for results: research question 2
##################################################
CreateTableOne(
  vars =
    c("MaternalAge",
      "BMI",
      "Ethnicitycoded",
      "GestationalAge",
      "Birthmode",
      "Analgesia coded",
      "Duration2ndstage",
      "Pushingduration",
      "Fetalposition",
      "Headcircumference",
      "Fetalweight"),
  strata = "Parity",
  data = tab_code,
  factorVars = c("Parity", "Ethnicitycoded", "Birthmode", "Analgesia coded", "Fetalposition")) %>%
  print(
    test = TRUE,
    showAllLabels = FALSE,
    explain = FALSE,
    nonnormal = FALSE,
    printToggle = FALSE,
    includeNA= FALSE) %>%
  as.data.frame %>%
  select(-test) -> M_0

knitr::kable(M_0, row.names = TRUE, booktabs = TRUE, format = "latex")

#Data preparation for impact factors
# table of means for continuous variables
tab_code %>%
  select(tear_pattern, BMI, GestationalAge, Fetalsex, Headcircumference, pHNSAbelow7.15, Pushingduration, Ethnicity

stat28 <- t_t28$`Tear pattern`

tab_code_n$tear_pattern <- factor(tab_code_n$tear_pattern, levels= stat28, order=TRUE)

#impact factor table of averages
tab_code_n %>%
  group_by_at(vars(Parity, tear_pattern)) %>%
 summarise_if(is.numeric, mean, na.rm=TRUE) %>%
  mutate_if(is.numeric, round, digits=1) %>%
  as.data.frame() -> tab_code_means
tab_code_means %>% # as parity increases, age also increases
```

```
  ggplot() +
  geom_tile(aes(y=tear_pattern, x = Parity, fill= MaternalAge)) +
  theme_minimal() +
  scale_colour_gradient(low ="lightyellow",
                        high = "purple",
                        aesthetics = "fill") +
  geom_text(aes(y=tear_pattern, x=Parity, label=MaternalAge), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill="Mean Maternal Age") -> tile_age
tile_age
# BMI
tab_code_means %>%
  ggplot() +
  geom_tile(aes(y=tear_pattern, x = Parity, fill= BMI)) +
  theme_minimal() +
  scale_colour_gradient(low= "lightyellow",
                        high = "pink",
                        aesthetics = "fill") +
  geom_text(aes(y=tear_pattern, x=Parity, label= BMI, size=3), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill="Mean BMI") -> tile_bmi
tile_bmi
tab_code_means %>%
  ggplot() +
  geom_tile(aes(y=tear_pattern, x = Parity, fill= GestationalAge)) +
  theme_minimal() +
  scale_colour_gradient(low= "lightyellow",
                        high = "darkgreen",
                        aesthetics = "fill") +
  geom_text(aes(y=tear_pattern, x=Parity, label=GestationalAge), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill="Mean Gestational Age") -> tile_ge
tile_ge
tab_code_means %>%
  ggplot() +
  geom_tile(aes(y=tear_pattern, x = Parity, fill= Duration2ndstage)) +
  theme_minimal() +
  scale_colour_gradient(low= "lightyellow",
                        high = "darkred",
                        aesthetics = "fill") +
  geom_text(aes(y=tear_pattern, x=Parity, label = Duration2ndstage), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill ="Mean Duration of 2nd Stage") -> tile_duration2nd
tile_duration2nd
# Pushing Duration
tab_code_means %>%
  ggplot() +
  geom_tile(aes(y=tear_pattern, x = Parity, fill = Pushingduration)) +
  theme_minimal() +
  scale_colour_gradient(low= "lightyellow",
                        high = "darkblue",
                        aesthetics = "fill") +
  geom_text(aes(y = tear_pattern, x = Parity, label = Pushingduration), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill ="Mean Pushing Duration") -> tile_pushing
tile_pushing
tab_code_means %>%
  ggplot() +
  geom_tile(aes(y = tear_pattern, x = Parity, fill = Headcircumference)) +
  theme_minimal() +
  scale_colour_gradient(low= "pink",
                        high = "darkviolet",
```

```
                          aesthetics = "fill") +
  geom_text(aes(y=tear_pattern, x=Parity, label = Headcircumference), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill="Mean Head Circumference") -> tile_hc
tile_hc
tab_code_means %>%
  ggplot() +
  geom_tile(aes(y=tear_pattern, x = Parity, fill = Fetalweight)) +
  theme_minimal() +
  scale_colour_gradient(low= "lightyellow",
                          high = "blue",
                          aesthetics = "fill") +
  geom_text(aes(y = tear_pattern, x = Parity, label = Fetalweight), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill="Mean Fetal weight") -> tile_w
tile_w

##################################################
####### code for results: research question 3
##################################################
tab_concodepar12$tear_patternP1 <- factor(tab_concodepar12$tear_patternP1, levels=stat10, ordered=TRUE)
tab_concodepar12$tear_patternP2 <- factor(tab_concodepar12$tear_patternP2, levels=stat10, ordered=TRUE)
tab_concodepar12 %>%
  ggplot() +
  geom_mosaic(aes(x = product(tear_patternP1, tear_patternP2), fill = tear_patternP1)) +
  theme_minimal() +
  labs(x = "Parity 1", y = "Parity 2", title = "") +
  theme(
    legend.position = "",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> mosaic_par12_top10tear_pattern
mosaic_par12_top10tear_pattern
tab_concodepar23$tear_patternP2 <- factor(tab_concodepar23$tear_patternP2, levels=stat10, ordered=TRUE)
tab_concodepar23$tear_patternP3 <- factor(tab_concodepar23$tear_patternP3, levels=stat10, ordered=TRUE)
tab_concodepar23 %>%
  ggplot() +
  geom_mosaic(aes(x = product(tear_patternP2, tear_patternP3), fill = tear_patternP2)) +
  theme_minimal() +
  labs(x = "Parity 2", y = "Parity 3", title = "") +
  theme(
    legend.position = "",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> mosaic_par23top10_tear_pattern
mosaic_par23top10_tear_pattern
tab_concodepar34$tear_patternP3 <- factor(tab_concodepar34$tear_patternP3, levels=stat10, ordered=TRUE)
tab_concodepar34$tear_patternP4 <- factor(tab_concodepar34$tear_patternP4, levels=stat10, ordered=TRUE)
tab_concodepar34 %>%
  ggplot() +
  geom_mosaic(aes(x = product(tear_patternP3, tear_patternP4), fill = tear_patternP3)) +
  theme_minimal() +
  labs(x = "Parity 3", y = "Parity 4", title = "") +
  theme(
    legend.position = "",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> mosaic_par23top10_tear_pattern
mosaic_par23top10_tear_pattern
tab_concodepar12$tear_patternP1 <- factor(tab_concodepar12$tear_patternP1, levels=nina10, ordered=TRUE)
tab_concodepar12$tear_patternP2 <- factor(tab_concodepar12$tear_patternP2, levels=nina10, ordered=TRUE)
tab_concodepar12 %>%
```

```
  ggplot() +
  geom_mosaic(aes(x = product(tear_patternP1, tear_patternP2), fill = tear_patternP1)) +
  theme_minimal() +
  labs(x = "Parity 1", y = "Parity 2", title = "") +
  theme(
    legend.position = "",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> mosaic_par23top10_tear_patternnina
mosaic_par23top10_tear_patternnina


tab_concodepar23$tear_patternP2 <- factor(tab_concodepar23$tear_patternP2, levels=nina10, ordered=TRUE)
tab_concodepar23$tear_patternP3 <- factor(tab_concodepar23$tear_patternP3, levels=nina10, ordered=TRUE)
tab_concodepar23 %>%
  ggplot() +
  geom_mosaic(aes(x = product(tear_patternP2, tear_patternP3), fill = tear_patternP2)) +
  theme_minimal() +
  labs(x = "Parity 2", y = "Parity 3", title = "") +
  theme(
    legend.position = "",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> mosaic_par23top10_tear_patternnina
mosaic_par23top10_tear_patternnina
tab_concodepar34$tear_patternP3 <- factor(tab_concodepar34$tear_patternP3, levels=nina10, ordered=TRUE)
tab_concodepar34$tear_patternP4 <- factor(tab_concodepar34$tear_patternP4, levels=nina10, ordered=TRUE)
tab_concodepar34 %>%
  ggplot() +
  geom_mosaic(aes(x = product(tear_patternP3, tear_patternP4), fill = tear_patternP3)) +
  theme_minimal() +
  labs(x = "Parity 3", y = "Parity 4", title = "") +
  theme(
    legend.position = "",
    panel.grid.major = element_blank(),
    panel.grid.minor = element_blank()) -> mosaic_par34top10_tear_patternnina
mosaic_par34top10_tear_patternnina
tab_code_means %>%
  ggplot() +
  geom_tile(aes(y=tear_pattern, x = Parity, fill = Bloodloss)) +
  theme_minimal() +
  scale_colour_gradient(low= "lightpink",
                      high = "darkred",
                      aesthetics = "fill") +
  geom_text(aes(y = tear_pattern, x = Parity, label = Bloodloss), size=3, colour="black") +
  labs(title ="", x = "Parity", y = "Tear patterns", fill="Mean Blood loss") -> tile_bl
tile_bl

#################################################
####### code for results: other outcome variables
#################################################
CreateTableOne(
  vars =
    c( "pHNSAbelow7.15",
       "APGAR2below7"),
  strata = "Parity",
  data = tab_code,
  factorVars = c("pHNSAbelow7.15", "APGAR2below7")) %>%
  print(
```

```
    test = TRUE,
    showAllLabels = FALSE,
    explain = FALSE,
    nonnormal = FALSE,
    printToggle = FALSE) %>%
  as.data.frame() %>%
  select(-test)-> Obs_other

knitr::kable(Obs_other, row.names = TRUE, booktabs = TRUE, format = "latex")


#################################################
####### the last chunk
#################################################
# Base packages:
s <- sessionInfo()
s1 <- s$basePkgs[1]
for (i in 2:length(s$basePkgs)){s1 <- paste(s1, ", ", s$basePkgs[i], sep = "")}

# Other Packages:
pack.info <- installed.packages()
output.packages <- data.frame(pack.info[names(s$otherPkgs) ,c("Package",
"Version")])

s2 <- paste(names(s$otherPkgs)[1],
output.packages[names(s$otherPkgs)[1], "Version"])
k <- length(names(s$otherPkgs))
if(k>1) for (i in 2:k){s2 <- paste(s2, ", ",
paste(names(s$otherPkgs)[i], output.packages[names(s$otherPkgs)[i],
"Version"]), sep = "")}
```