Analysing Menstrual Products and Birth-Related Issues from NFHS-4 and NFHS-5

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***Abstract*—This research primarily investigates the role of different menstrual products on pregnancy conditions, and any possible complications, by corroborating it with the IABR dataset in NFHS-4 and NFHS-5. The attributes that stood out surrounded the different components of menstruation, pregnancy complications, birth issues, hemoglobin levels, mother's age and delivery costs and circumstances are used to find associations between menstrual products (like cloth, sanitary napkins, tampons, menstrual cup, local prepping, none) and pregnancy complications (vaginal bleeding, convulsions, prolonged labour, severe abdominal pain, high blood pressure). In order to draw insightful conclusions from our datasets we performed clustering, to explain the distribution of period products over different chosen clusters and association rule mining, to establish association rules for the attributes of interest. Temporal analysis was also performed using regression to understand the behavior according to the variations in the attributes over time.**

***Index Terms*—data mining, national health survey, menstrual products, abortion, pregnancy complications, data visualisation, clustering, association-rule mining**

I. Introduction

The National Family Health Survey (NFHS) is an extensive, multi-round survey that is carried out in a representative sample of Indian households, consisting of state and national information on a multitude of concepts. From the data acquired by the DHS survey, four main questionnaires were studied - a Household Questionnaire, a Biomarker Questionnaire, a Woman's Questionnaire, and a Man's Questionnaire; out of which the BR code, (IABR dataset) was chosen for analysis, as it contained information about the full birth history of all women interviewed, pregnancy and postnatal care, that seemed of interest. Certain microbes, like the anaerobic species, Lactobacillus were found to dominate the vaginal environments in uncomplicated pregnancies, across all cycles. The presence of Lactobacillus is of extreme importance to the vagina to safeguard the woman from genital infections. Consequently, Lactobacillus deficient conditions were further linked to the emergence of several infectious diseases, including bacterial vaginosis (BV) and aerobic vaginitis (AV), the occurrences of which have been associated with pregnancy complications like premature birth or spontaneous abortion. After a detailed understanding of the dataset, In order to constructively find any correlations, we define our problem statement to be "finding the degree of impact of menstrual products on birth and complications related to birth". We also considered the factor of smoking habits because literature survey has informed us of the obvious negative implications of smoking during pregnancy and didn't want that to interfere with the influence of menstrual products. The argument was built upon scrutinizing our datasets, by subjecting it to cleaning and preprocessing techniques like binning, aggregation, supervised entropy discretization, unsupervised discretization - equal interval binning and normalization to scale our data to a range so as to maximize inferences, as well as data visualization for further data exploration. In order to draw insightful conclusions from our datasets we performed clustering, to explain the distribution of period products over different chosen clusters and association rule mining, to establish association rules for the attributes of interest. Temporal analysis was also performed using regression analysis to understand the behavior according to the variations in the attributes over time.

II. Problem Statement

To find the degree of correlation between, patterns in and impact of various menstrual products on childbirth, pregnancy and infancy issues in the NFHS-4 and NFHS-5 datasets.

III. Literature Survey

Several research papers commented on the effect of changing external (and internal) factors on the vaginal health and microbiota. These pronounced shifts were concluded and confirmed by the huge extent of data varying from the increased diagnosis of a fungal genital infection in menstrual cup users to the dynamic nature of the vaginal ecosystem with respect to factors like the menstrual cycle, pregnancy, use of contraceptive agents, frequency of sexual intercourse, specific sexual partners, vaginal douching, use of panty liners or vaginal deodorants, and the utilization of antibiotics or other medications with immune or endocrine activities, amongst others. Additionally, inconsistent vaginal flora during pregnancy is linked to preterm labour and delivery, which may result in neonatal sequelae because of prematurity and poor perinatal outcome. Many aspects of foetal development, physiological function, immunity at mucosal surfaces, susceptibility to illnesses, and capacity to digest nutrients are influenced by commensal microbiota associated with the human body. In order to preserve vaginal health and prevent infections, commensals in the lower female reproductive tract are important. In a study collected on uncomplicated pregnancies, samples were collected which were dominated by the genus Lactobacillus, with few species shift between L. crispatus and L. iners, over the course of the pregnancy. Thus, the anaerobic species Lactobacillus was found to dominate the vaginal microbiota of a healthy, asymptomatic woman and to keep the natural, healthy balance of the vaginal flora and to safeguard women from genital infections, Lactobacillus activity is crucial. It was also made evident that here lactobacilli predominate, other bacteria and parasites are not abundant. Lactobacillus deficiency is linked to the emergence of several infectious diseases, including BV and A, suggesting that the absence of lactobacilli, rather than the presence of other microorganisms, appears to be the factor that exposes the risk of preterm birth, and they also imply that a test for the presence of vaginal lactobacilli may be a clinically useful tool for identifying women at risk for preterm delivery at or before 33 weeks of gestation. It has also been observed that up to 20% of pregnant women experience bacterial vaginosis, which has been linked to spontaneous abortion and early birth. Vaginal infections are associated with a major increase in risk of preterm birth in women and can also can lead to pelvic inflammatory diseases (PID), which can cause tubal infertility, ectopic pregnancy, reproductive dysfunction, and adverse pregnancy outcomes (including preterm delivery and low birth weight), if untreated. They may even lead to the development of cervical dysplasia, a higher risk of postpartum infections, HIV, and the acquisition and transmission of herpes simplex virus-2 (HSV-2). There is still little agreement on treatment options for preterm delivery because it is still unclear why specific vaginal infections, including BV in particular, cause premature birth in some women but not in others.

IV. Preprocessing

Upon pre-processing, 3 separate and condensed datasets were generated: smoke-free, terminated pregnancies, and complications in abortion. Terminated pregnancies are a subset of smoke-free, and complications in abortion are a subset of the terminated pregnancies datasets.

In order to prepare data for analysis, it is necessary to clean, transform, and integrate the data, which come unders data preprocessing.

A. Feature Subset Selection and Aggregation

The preprocessing of the data was carried out on the basis of extensive literature survey (which included decent information regarding our chosen attributes with some gaps giving us enough reason to investigate and research further) and related domain knowledge. Firstly, features related to period products used, smoking habits, birth weight, birth size, urban/rural setting, first period age, pregnancy termination, and complications in pregnancy are extracted. Then, this data is cleaned by eliminating the samples where the person smokes, and empty cells are either filled or removed depending on how many missing values there are. The preprocessing techniques employed are: data cleaning and smoothing, feature subset selection, aggregation, and entropy-based discretization, and unsupervised-discretization.

B. Data-cleaning

In the data-cleaning step, by aggregating the features of drug consumption, as it is a known fact that they affect birth, and depending on what the new 'SMOKE' feature value is, we remove the samples where smoking corresponds to a positive value. After this, the missing values in birth weights and birth sizes are filled in with the respective global median.

C. Entropy-based Discretization

For entropy-based discretization, 2 types of splits containing 3 bins each are made, where one groups the extremities in birth sizes (Split 1): 1,5, 2,4, and 3, while the other groups the sizes as 1,2, 3, and 4,5 (Split 2). Then, the number of complications in abortion of the next pregnancy was matched with each of these bins. For this, the complications in abortion dataset was used. Using the Shannon Information metric, it was found that the first split, Split 1, contained more information.

TABLE I
Entropy-Based Discretization of birth sizes and complications in abortion in NFHS-4

	Splits		
	Bins	***Not Complicated***	***Complicated***
Split 1	Bin 1: {1,5}	147	28
	Bin 2: {2,4}	357	87
	Bin 3: {3}	1356	271
Split 2	Bin 1: {1,2}	270	73
	Bin 2: {4,5}	234	87
	Bin 3: {3}	1356	271

{$mathrm$Split 1 entropy= 0.66; Split 2 entropy = 0.7

TABLE II
Entropy-Based Discretization of birth sizes and complications in the next abortion in NFHS-5

	Splits		
	Bins	***Not Complicated***	***Complicated***
Split 1	Bin 1: {1,5}	119	22
	Bin 2: {2,4}	313	37
	Bin 3: {3}	1367	203
Split 2	Bin 1: {1,2}	253	36
	Bin 2: {4,5}	179	37
	Bin 3: {3}	1367	203

Split 1 entropy= 0.55; Split 2 entropy = 0.56

D. Equal-interval Binning

Unsupervised discretization with equal width/interval binning performed on the following attributes - haemoglobin levels and age at death of child (both divided into three bins) would help chunk together data values and provided cleaner data to use for Association Rule Mining.

TABLE III
EQUAL-INTERVAL BINNING IN NFHS-4

	Splits	
	Interval	***Bin Size***
Haemoglobin Levels Adjusted to Altitude	[12,87]	7832
	(87,162]	84116
	(162,237]	32
Age at Death of First Child	(100,170]	89281
	(170,240]	1099
	(240, 310]	307

TABLE IV
EQUAL-INTERVAL BINNING IN NFHS-5

	Splits	
	Interval	***Bin Size***
Haemoglobin Levels Adjusted to Altitude	(20,88]	9709
	(88,156]	72787
	(156,224]	40
Age at Death of First Child	(100,169]	80463
	(169, 238]	942
	(238, 307]	201

V. DATA VISUALISATION

For the data visualization, the following codes are used for the period products: 1- Cloth; 2- Local prep; 3- Sanitary napkin; 4- Tampon; 5- Nothing(2015)/Menstrual cup(2019); 6- Other(2015)/Nothing(2019); and 7- Other(2019).

- Using the smoke-free dataset, the relationships between and distributions in the birth weights and birth sizes with respect to the menstrual product used have been visualised for both NFHS-4 and NFHS-5.

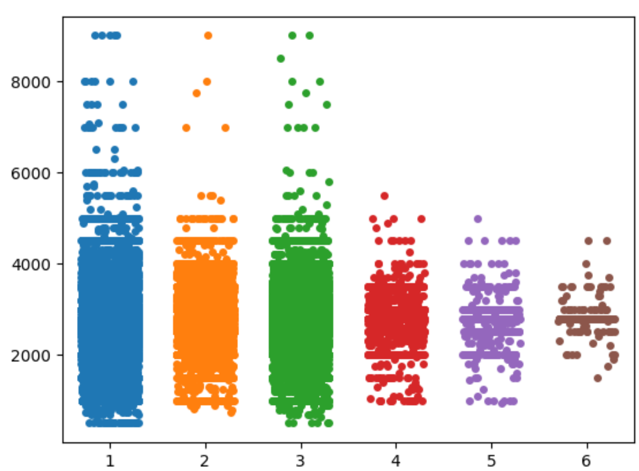

Fig. 1. period product and birth weight, NFHS-4

- It is observed that for all approach to menstrual care (use of cloth/local preparation/sanitary napkins/nothing/others) the child at birth was mostly average-sized. However for nothing used, the percentage of babies that were smaller than average at birth is considerably higher, than for other menstrual products

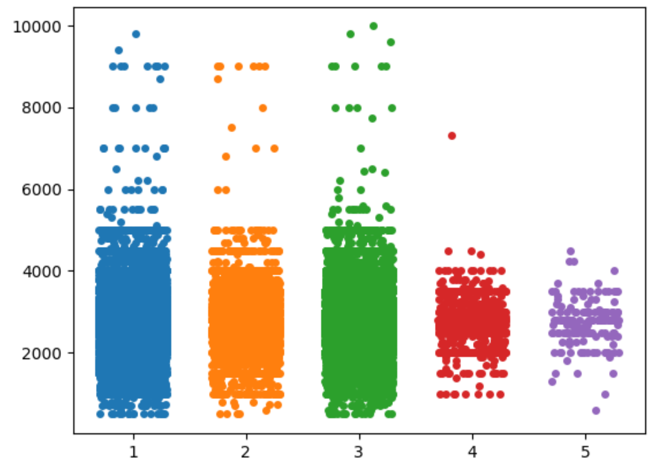

Fig. 2. period product and birth weight, NFHS-5

used. Very large babies were observed least when cloth was used and most when tampons were used.

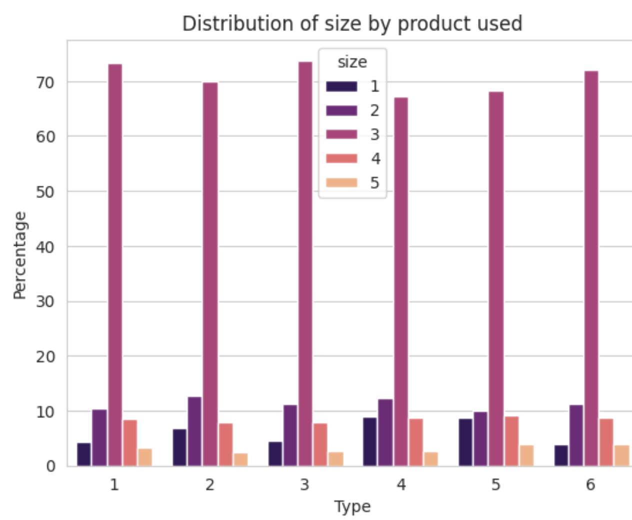

Fig. 3. period product and birth size distribution, NFHS-4

- With the terminated pregnancies and complications in abortion datasets respectively, their correlations with the type of menstrual product used have also been examined.

- It was observed that for tampons or menstrual cups used, percentage of women with pregnancy terminated in the 7th month was higher than the rest by a considerable margin. While for cloth or local prep used, pregnancies were mostly terminated in the 5th month. Women who used cloth or local prep showed similar patterns in terms of month pregnancy was terminated as well as women who used tampons or menstrual cups.
- It was observed that for women who used no menstrual product, percentage of complications in abortion were the highest, even succeeding the percentage of women using

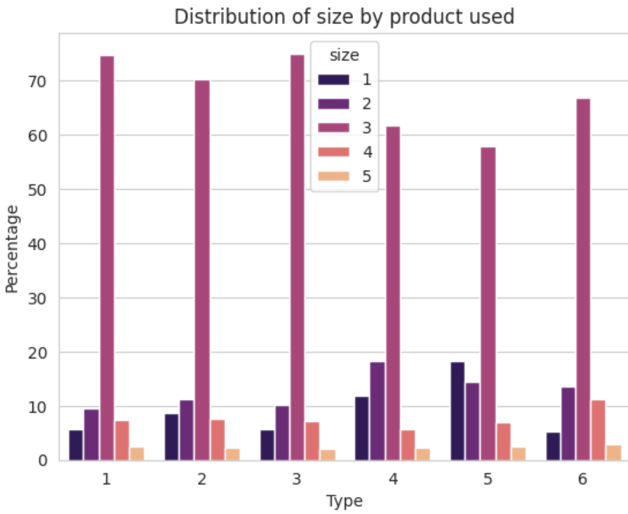

Fig. 4. period product and birth size distribution, NFHS-5

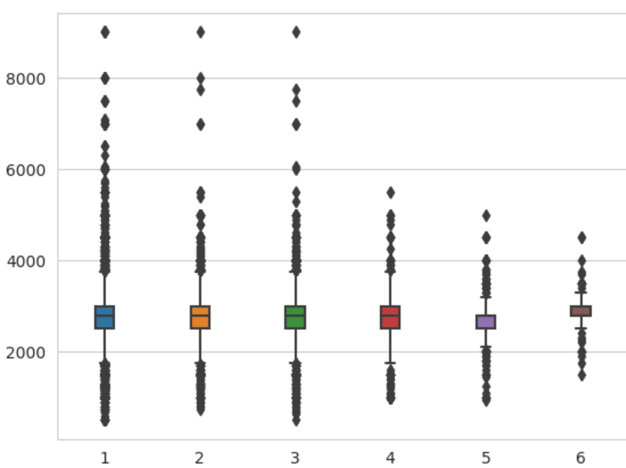

Fig. 5. boxplot of period product and birth weight, NFHS-4

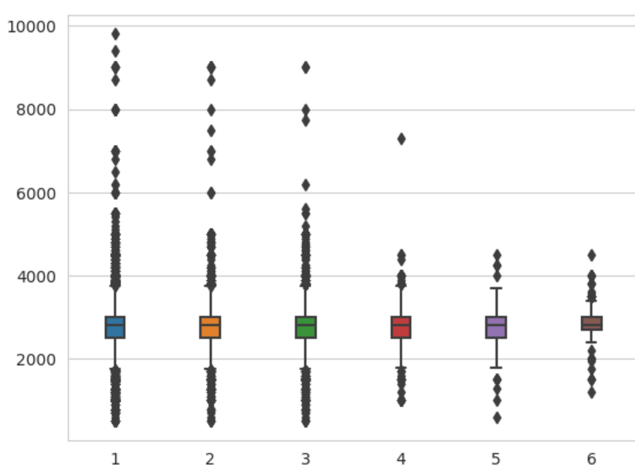

Fig. 6. boxplot of period product and birth weight, NFHS-5

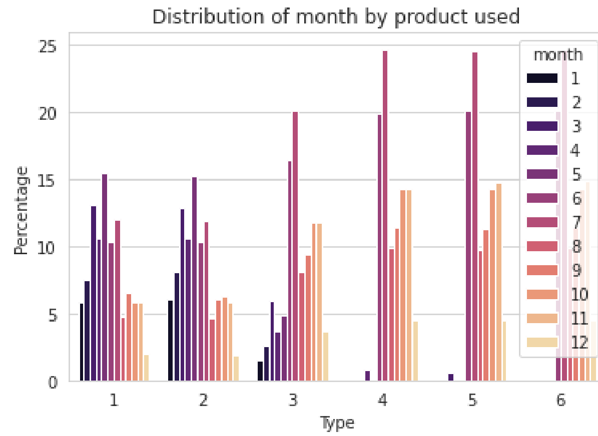

Fig. 7. period product and month pregnancy was terminated, NFHS-4

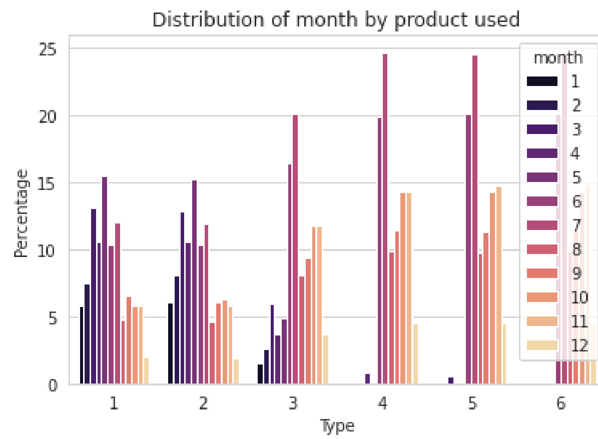

Fig. 8. period product and month pregnancy was terminated, NFHS-5

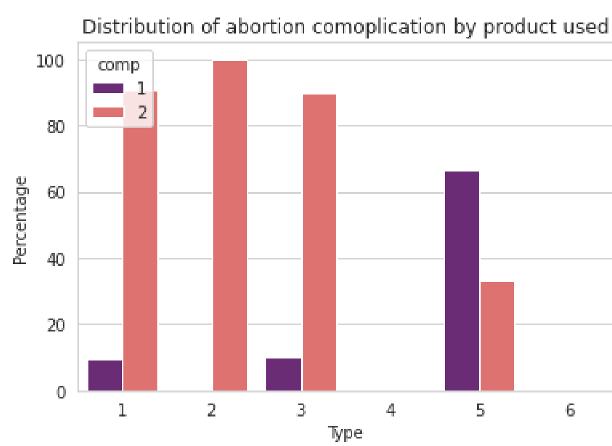

Fig. 9. period product and distribution of complication in abortion, NFHS-4

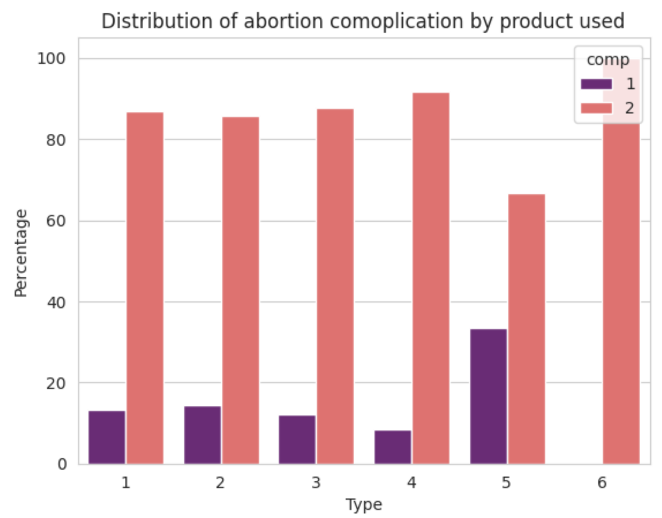

Fig. 10. period product and distribution of complication in abortion, NFHS-5

no menstrual product with no complications in abortion by a decent margin. The percentage of women using local prep had the highest percentage of no complications in abortion.

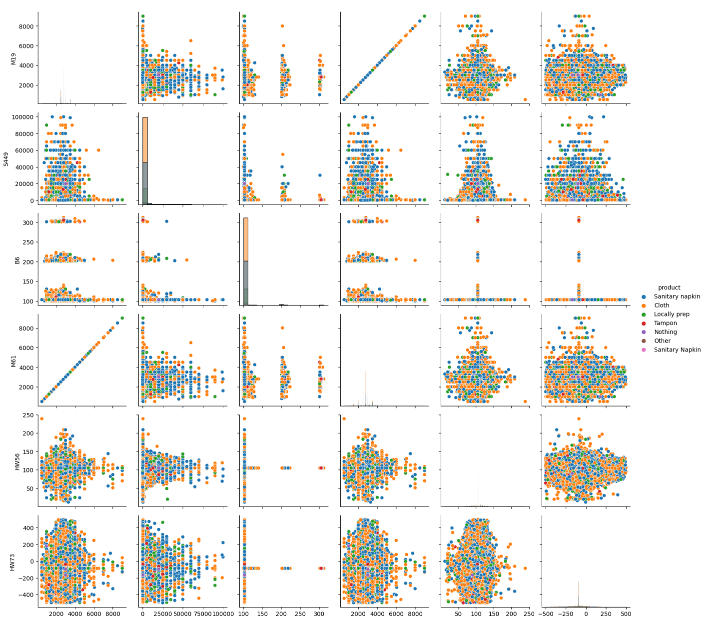

Fig. 11. pair plot of various features, NFHS-4

- From the NFHS-4 pair plots, it can be inferred that the age at death & birth weight, age at death & the time spent at the place of delivery, birth weight & haemoglobin levels, birth weight & BMI standard deviation, time spent at the place of delivery & haemoglobin levels, and time spent at the place of delivery & BMI standard deviation show cluster-like entities. The striking correlation between birth-weight and the time spent at the place of delivery must also be noted.

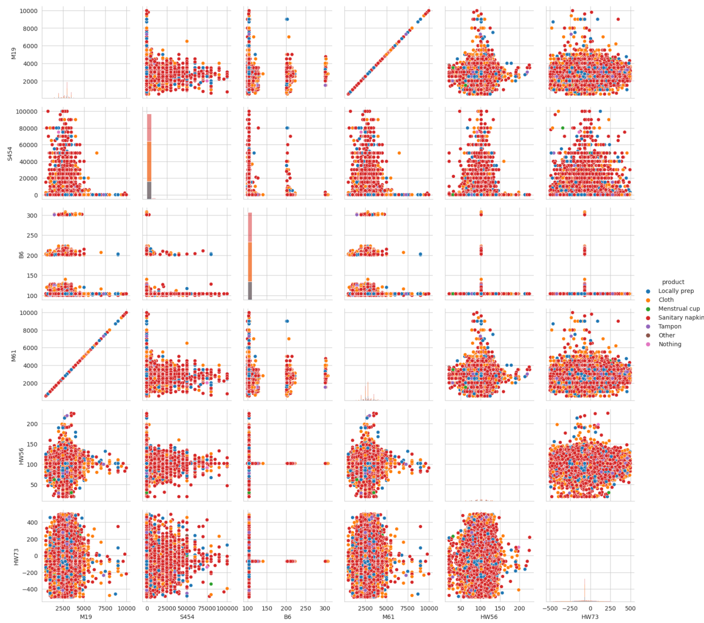

Fig. 12. pair plot of various features, NFHS-5

- From the NFHS-5 pair plots, it can be observed that the birth weight & BMI standard deviation, time spent at the place of delivery & haemoglobin levels show the most cluster-like plots. The striking correlation between birth-weight and the time spent at the place of delivery continues to persist.

VI. Association-Rule Mining

Association Rule Mining was carried out using the Apriori Algorithm in order to establish relationships/associations based on frequent occurrences between our chosen attributes which were period products, termination of pregnancy and complications in pregnancy. Based on the support and confidence values of these itemsets, a list of all possible values was made for those which qualified the minimum support and confidence threshold.

For the NFHS-4 dataset, below are the rules observed:

- (Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (High Blood Pressure) → (Complication from Abortion); Confidence: 0.974
- (Convulsions) → (Complication from Abortion); Confidence: 0.975
- (Prolonged Labour) → (Complication from Abortion); Confidence: 0.975
- (Severe Abdominal Pain) → (Complication from Abortion); Confidence: 0.974
- (Vaginal Bleeding) → (Complication from Abortion); Confidence: 0.975
- (Size of Child at Birth) → (Complication from Abortion); Confidence: 0.974
- (Cloth) → (Complication from Abortion); Confidence: 0.975

- (Severe Abdominal Pain, Prolonged Labour)-¿ (Complication from Abortion); Confidence: 0.975
- (Cloth, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (Termination of Pregnancy, Vaginal Bleeding) → (Complication from Abortion); Confidence: 1.0
- (Size of Child at Birth, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (High Blood Pressure, Severe Abdominal Pain) → (Complication from Abortion); Confidence: 0.975
- (Prolonged Labour, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (High Blood Pressure, Prolonged Labour) → (Complication from Abortion); Confidence: 0.975
- (Cloth, Size of Child at Birth) → (Complication from Abortion); Confidence: 0.976
- (High Blood Pressure, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (Severe Abdominal Pain, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (High Blood Pressure, Severe Abdominal Pain, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (Severe Abdominal Pain, Prolonged Labour, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0
- (High Blood Pressure, Severe Abdominal Pain, Prolonged Labour) → (Complication from Abortion); Confidence: 0.975
- (Cloth, Size of Child at Birth, Termination of Pregnancy) → (Complication from Abortion); Confidence: 1.0

For the NFHS-5 dataset no association rules were observed as the itemsets didn't meet the minimum support and confidence threshold values.

VII. CLUSTERING

Clustering was performed to find smaller groups (or clusters) of data values that showed properties similar to one another, and distinctly different from another few. K-means was used for clustering to define the prototype in terms of a centroid, where each point is assigned to the closest centroid and each collection of points associated with a centroid makes one cluster. To calculate the distance between a point and a centroid to determine if it's the nearest, Euclidean distance was used as the proximity measure. From the plots that were obtained, clustering was performed only for 8 of them, as they could be visibly separated into major clusters and would yield the most meaningful conclusions. Based on these clusters we also wanted to investigate which period product dominates each cluster or how the distribution of period products across these plot of different attributes looks like.

From NFHS-4, clustering was done for hemoglobin levels vs. birth weight, bmi standard deviation vs. birth weight, hemoglobin levels vs. time spent at delivery, bmi standard deviation vs. time spent at delivery, birth weight vs. age at death of first child, time spent at delivery vs. age at death of first child and from NFHS-5, it was done for bmi standard deviation vs. birth weight and hemoglobin levels vs. time spent at delivery. 3 clusters were yielded per chart with the centroids:

TABLE V
CLUSTERS IN NFHS-4

Clusters	**Paramter Centroids**	
Fig 14	***Birth Weight***	***Hemoglobin Levels***
Cluster 1	2019.79	107.61
Cluster 2	2916.2	103.91
Cluster 3	6543.36	103.17
Fig 16	***Birth Weight***	***BMI Standard Deviation***
Cluster 1	1889.58	-112.03
Cluster 2	2900.26	-87.60
Cluster 3	6569.24	-91.76
Fig 18	***Time Spent, Delivery***	***Hemoglobin Levels***
Cluster 1	2895.75	-112.03
Cluster 2	1889.89	103.08
Cluster 3	5570.77	103.47
Fig 20	***Time Spent, Delivery***	***BMI Standard Deviation***
Cluster 1	2822.34	-89.60
Cluster 2	1394.02	-121.85
Cluster 3	7725.0	-97.31
Fig 22	***Age at Death, Child***	***Birth Weight***
Cluster 1	103.00	2775.49
Cluster 2	204.25	2737.90
Cluster 3	302.35	2764.70
Fig 24	***Age at Death, Child***	***Time Spent, Delivery***
Cluster 1	103.00	2775.49
Cluster 2	204.25	2737.90
Cluster 3	302.35	2764.70

TABLE VI
CLUSTERS IN NFHS-5

Clusters	**Paramter Centroids**	
Fig 26	***Birth Weight***	***BMI Standard Deviation***
Cluster 1	3180.91	21.48
Cluster 2	2570.10	-116.23
Cluster 3	7097.31	-78.5
Fig 28	***Time Spent, Delivery***	***Hemoglobin Levels***
Cluster 1	3180.91	21.48
Cluster 2	2570.10	-116.23
Cluster 3	7097.31	-78.5

VIII. TEMPORAL ANALYSIS

Temporal analysis was performed by us because investigate and model our attributes' behaviour through time by analyzing variations in the NFHS-4 and NFHS-5 data. A comparison of distribution of period products in 2015 and 2019 was done and graphs were charted for the same. Linear regression analysis was performed to for the attributes - hemoglobin levels and time spent at place of delivery, and a plot was made to show the relation between the same. As observed from the plot, the trend for their relationship was very similar for both, NFHS-4 as well as NFHS-5 datasets.

CONCLUSION

To conclude, the literature survey gave enough information to believe that research into the effect of exogenous factors on the vaginal health as well as that of vaginal infections

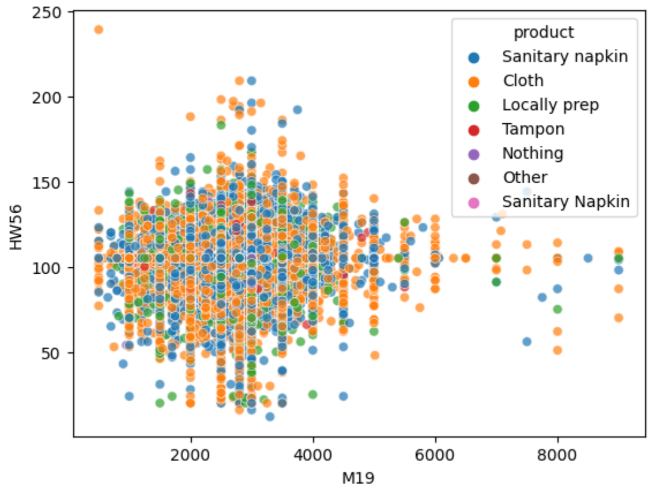

Fig. 13. product distribution in birthweight and haemoglobin levels, NFHS-4

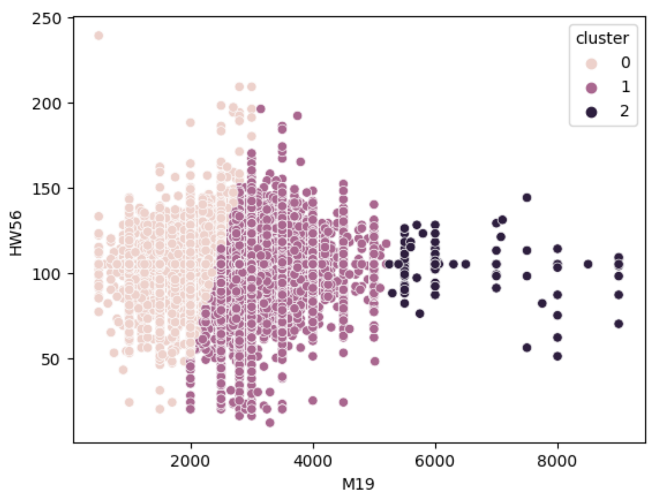

Fig. 14. clusters in birthweight and haemoglobin-levels, NFHS-4

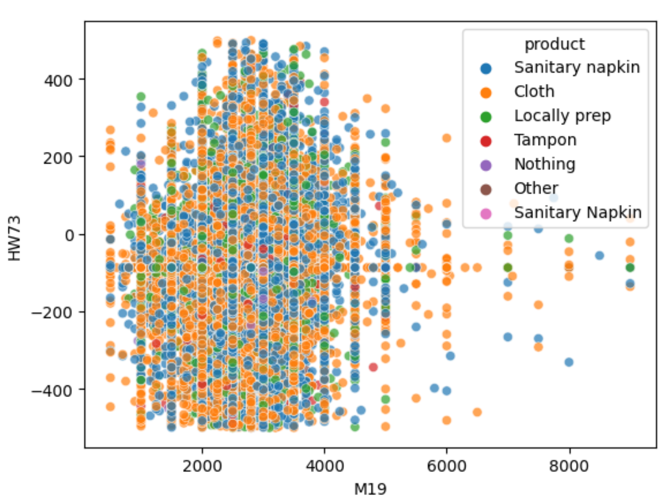

Fig. 15. product distribution in birthweight and BMI SD levels, NFHS-4

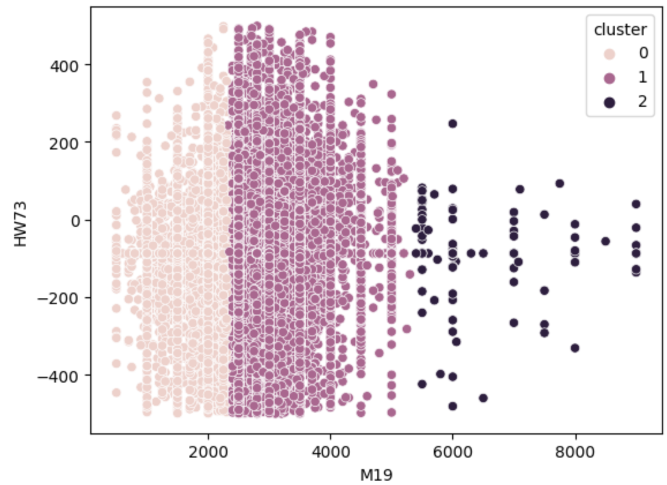

Fig. 16. clusters in birthweight and BMI SD, NFHS-4

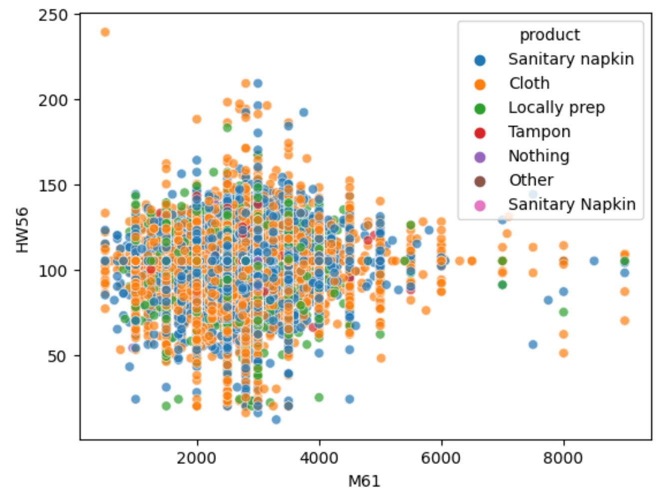

Fig. 17. product distribution in time spent at the place of delivery and haemoglobin levels, NFHS-4

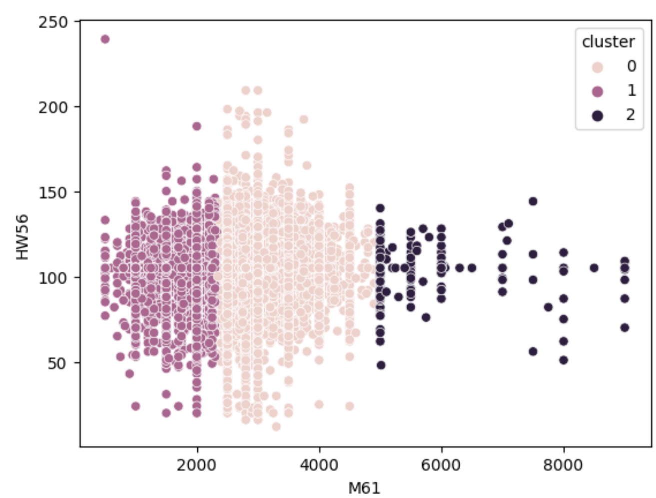

Fig. 18. clusters in time spent at the place of delivery and haemoglobin levels, NFHS-4

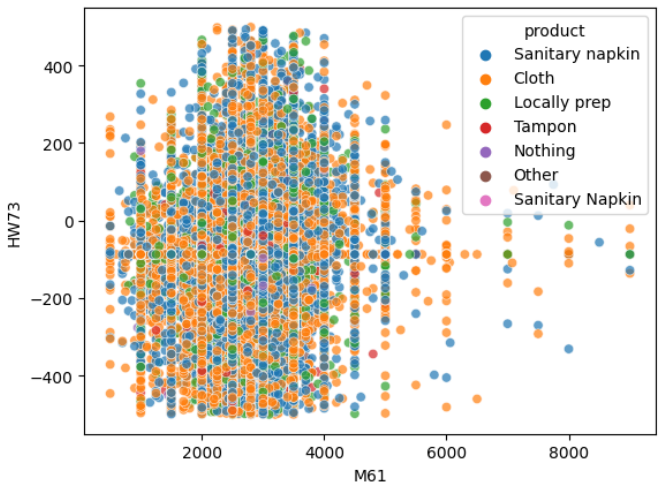

Fig. 19. product distribution in time spent at the place of delivery and BMI SD, NFHS-4

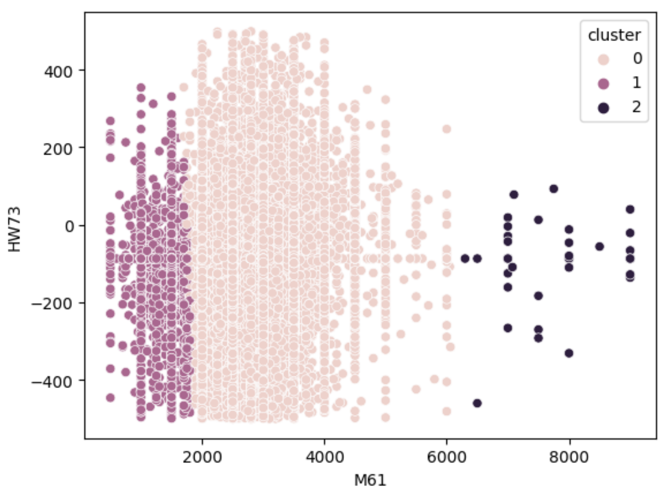

Fig. 20. clusters in time spent at the place of delivery and BMI SD, NFHS-4

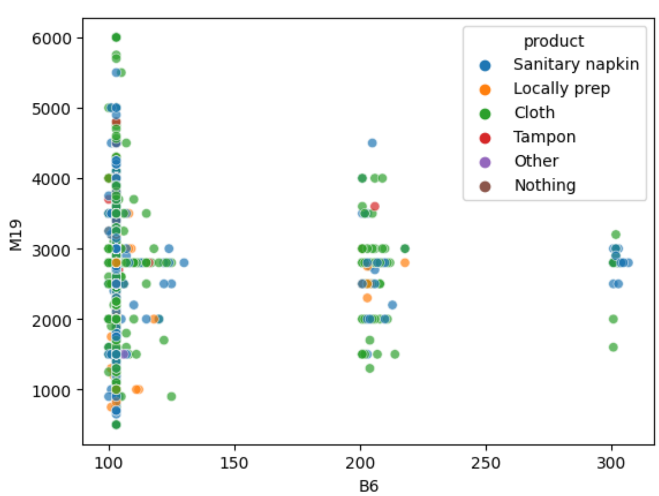

Fig. 21. product distribution in age at death and birthweight, NFHS-4

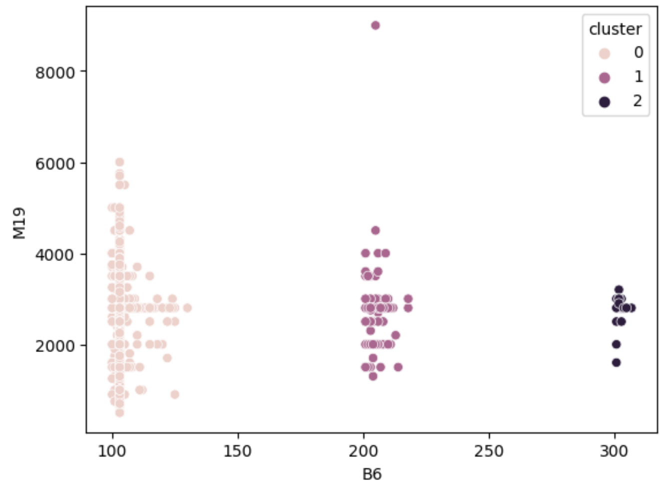

Fig. 22. clusters in age at death and birthweight, NFHS-4

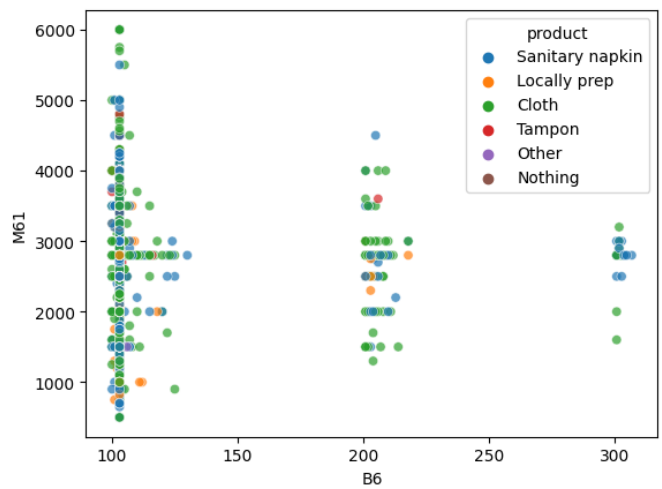

Fig. 23. product distribution in age at death and time spent at the place of delivery, NFHS-4

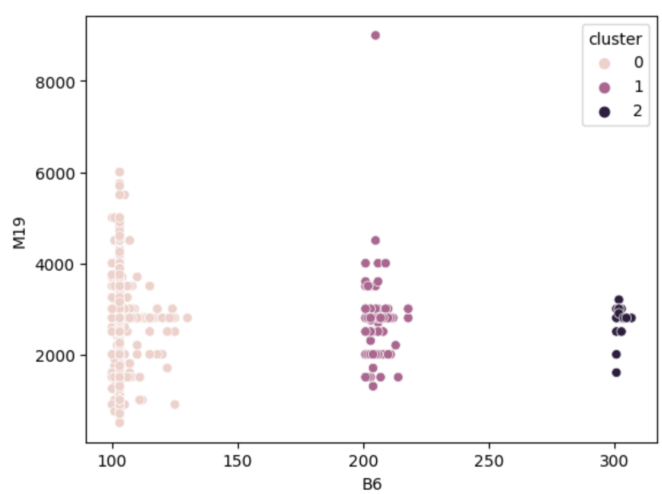

Fig. 24. clusters in age at death and time spent at the place of delivery, NFHS-4

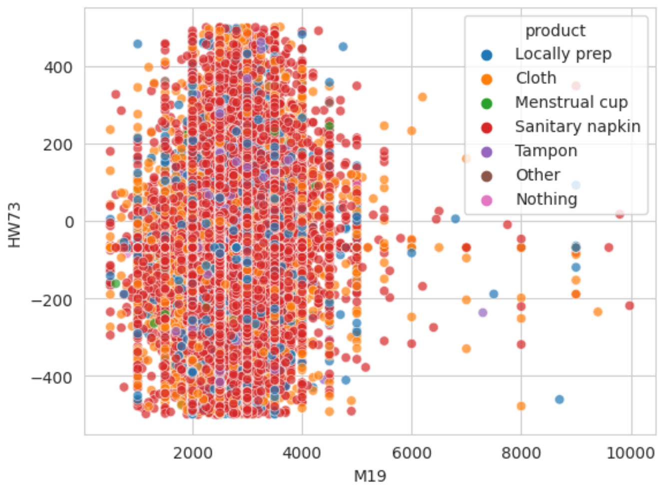

Fig. 25. product distribution in birth weight and BMI SD, NFHS-5

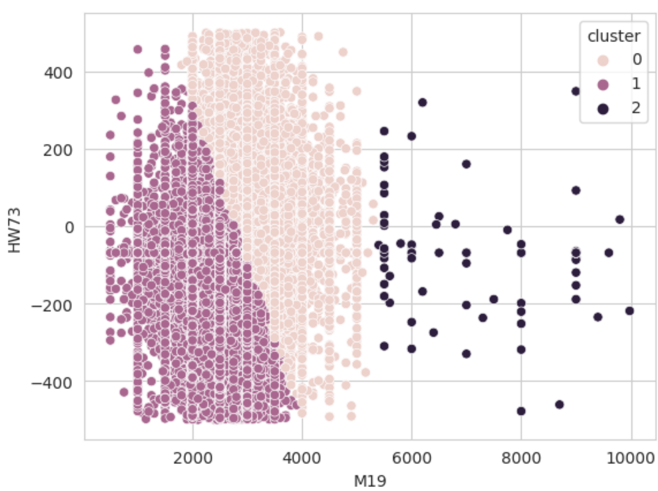

Fig. 26. clusters in birthweight and BMI SD, NFHS-5

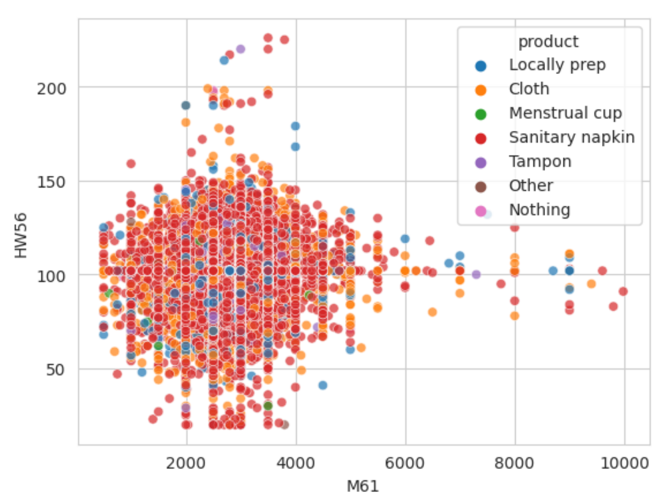

Fig. 27. product distribution in time spent at the place of delivery and haemoglobin levels, NFHS-5

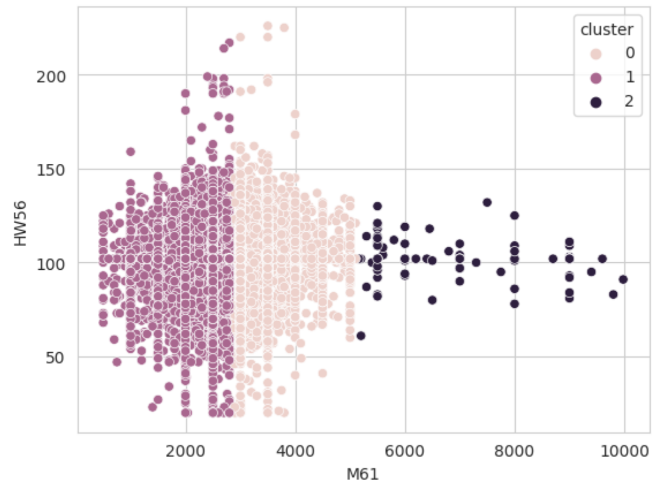

Fig. 28. clusters in time spent at the place of delivery and haemoglobin levels, NFHS-5

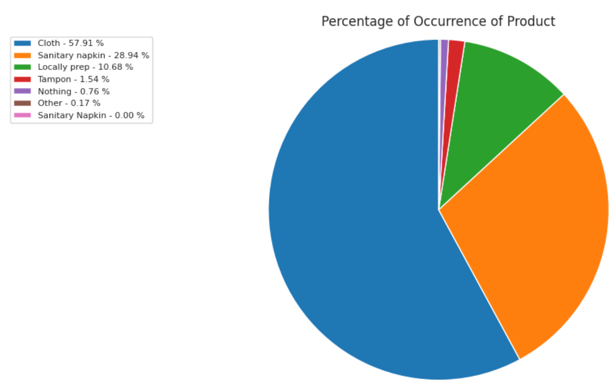

Fig. 29. distribution of period products in 2015

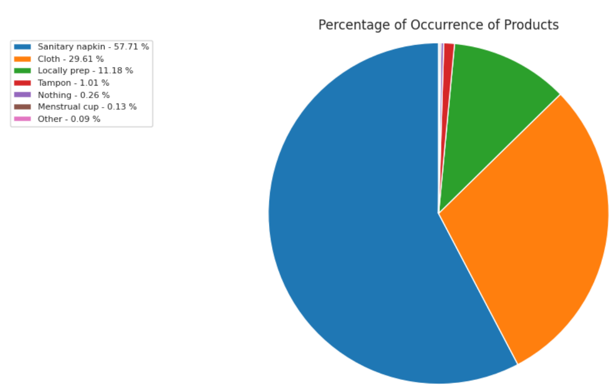

Fig. 30. distribution of period products in 2019

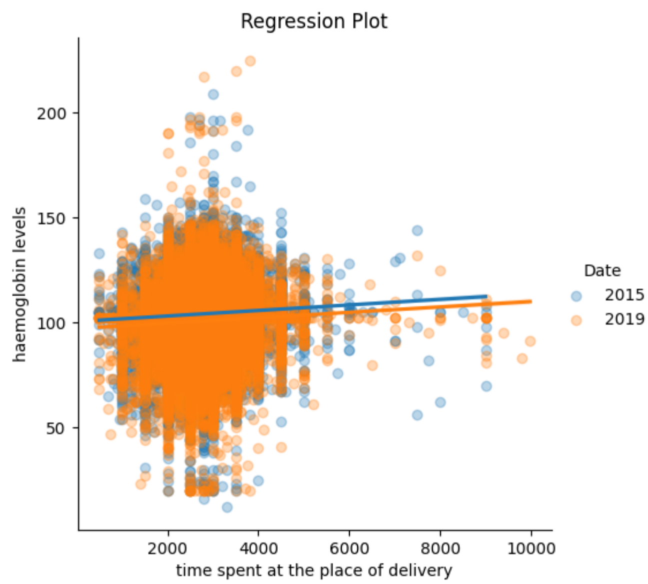

Fig. 31. Haemoglobin levels and time spent at the place of delievry: Trend

on pregnancy conditions is scarce and highly needed. From our thorough data preprocessing and visualization we could also infer the meaningfulness of the data, allowing us to further expand on it and read our data more extensively. By employing data analysis techniques like association rule mining and clustering on the cleaned, scaled, and preprocessed data satisfactory meaningful inferences and conclusive association were obtained. An extremely strong, nearly linearl correlation was observed in the plots for time spent at place of delivery and birth weight. Similarly, the clusters provided us some understanding about the distribution of period products across different relations of attributes, while association rule mining gave us indicated association rules, both of which incentivize us to further pursue research under the defined problem statement.

References

[1] Donati L, Di Vico A, Nucci M, Quagliozzi L, Spagnuolo T, Labianca A, Bracaglia M, Ianniello F, Caruso A, Paradisi G. Vaginal microbial flora and outcome of pregnancy. Arch Gynecol Obstet. 2010 Apr;281(4):589-600. doi: 10.1007/s00404-009-1318-3. Epub 2009 Dec 5. PMID: 19967381.

[2] Tessandier, N., Uysal, I. B., Elie, B., Selinger, C., Bernat, C., Boué, V., Grasset, S., Groc, S., Rahmoun, M., Reyné, B., Bender, N., Bonneau, M., Graf, C., Tribout, V., Foulongne, V., Ravel, J., Waterboer, T., Hirtz, C., Bravo, I. G., … Alizon, S. (2022). Does exposure to different menstrual products affect the vaginal environment? In Molecular Ecology. Wiley. https://doi.org/10.1111/mec.16678

[3] Cnattingius, S. (2004). The epidemiology of smoking during pregnancy: Smoking prevalence, maternal characteristics, and pregnancy outcomes. In Nicotine &; Tobacco Research (Vol. 6, pp. 125–140). Oxford University Press (OUP). https://doi.org/10.1080/14622200410001669187

[4] Onderdonk, A. B., Zamarchi, G. R., Rodriguez, M. L., Hirsch, M. L., Muñoz, A., & Kass, E. H. (1987). Qualitative assessment of vaginal microflora during use of tampons of various compositions. In Applied and Environmental Microbiology (Vol. 53, Issue 12, pp. 2779–2784). American Society for Microbiology. https://doi.org/10.1128/aem.53.12.2779-2784.1987

[5] Sturm, P. D. J., Moodley, P., Nzimande, G., Balkistan, R., Connolly, C., & Sturm, A. W. (2002). Diagnosis of bacterial vaginosis on self-collected vaginal tampon specimens. In International Journal of STD amp; AIDS (Vol. 13, Issue 8, pp. 559–563). SAGE Publications. https://doi.org/10.1258/095646202760159693

[6] Wilkinson, D., Ndovela, N., Kharsany, A., Connolly, C., & Sturm, A. W. (1997). Tampon sampling for diagnosis of bacterial vaginosis: a potentially useful way to detect genital infections? In Journal of Clinical Microbiology (Vol. 35, Issue 9, pp. 2408–2409). American Society for Microbiology. https://doi.org/10.1128/jcm.35.9.2408-2409.1997

[7] Hickey, R., Abdo, Z., Zhou, X., Nemeth, K., Hansmann, M., Osborn, T., III, Wang, F., & Forney, L. (2013). Effects of tampons and menses on the composition and diversity of vaginal microbial communities over time. In BJOG: An International Journal of Obstetrics &; Gynaecology (Vol. 120, Issue 6, pp. 695–706). Wiley. https://doi.org/10.1111/1471-0528.12151

[8] Anthony W. Chow, Karen H. Bartlett, Sequential Assessment of Vaginal Microflora in Healthy Women Randomly Assigned to Tampon or Napkin Use, Reviews of Infectious Diseases, Volume 11, Issue Supplement 1, January-February 1989, Pages S68–S74, https://doi.org/10.1093/clinids/11.Supplement 1.S68

[9] Walther-António, R. S., Jeraldo, P., Berg Miller, M. E., Yeoman, C. J., Nelson, K. E., Wilson, B. A., White, B. A., Chia, N., & Creedon, D. J. (2014). Pregnancy's Stronghold on the Vaginal Microbiome. PLOS ONE, 9(6), e98514. https://doi.org/10.1371/journal.pone.0098514

[10] Titaley, C.R., Dibley, M.J., Agho, K. et al. Determinants of neonatal mortality in Indonesia. BMC Public Health 8, 232 (2008). https://doi.org/10.1186/1471-2458-8-232

[11] Paranjothy S, Broughton H, Adappa R, et al Teenage pregnancy: who suffers? Archives of Disease in Childhood 2009;94:239-245.

[12] van Katwijk, C. (1998). Clinical aspects of pregnancy after the age of 35 years: a review of the literature. In Human Reproduction Update (Vol. 4, Issue 2, pp. 185–194). Oxford University Press (OUP). https://doi.org/10.1093/humupd/4.2.185

[13] Bellanger, M. M., Or, Z. (2008). What can we learn from a cross-country comparison of the costs of child delivery? In Health Economics (Vol. 17, Issue S1, pp. S47–S57). Wiley. https://doi.org/10.1002/hec.1325

[14] Pyeritz, R. E. (1981). Maternal and fetal complications of pregnancy in the Marfan syndrome. In The American Journal of Medicine (Vol. 71, Issue 5, pp. 784–790). Elsevier BV. https://doi.org/10.1016/0002-9343(81)90365-x

[15] Kristensen, J., Vestergaard, M., Wisborg, K., Kesmodel, U., Secher, N. J. (2005). Pre-pregnancy weight and the risk of stillbirth and neonatal death. In BJOG: An International Journal of Obstetrics and Gynaecology (Vol. 112, Issue 4, pp. 403–408). Wiley. https://doi.org/10.1111/j.1471-0528.2005.00437.x