Acta Scientific Clinical Case Reports

Volume 2 Issue 9 September 2021

Research Article

Induced Abortion Trends for Senior Women (≥ 35 Years Old) in New Zealand Between 2000--2019

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Received: July 16, 2021

Published: August 10, 2021

Abstract

Senior women (≥ 35) pregnancies and linked induced abortions always indicate a serious women's health issue. Any woman age ≥ 35 years old is considered herein as a senior. The induced abortions trends of senior women in New Zealand for the period 2000 to 2019 is determined in the current article. Senior women are grouped into three age groups such as 35 - 39, 40 - 44 and ≥ 45 years old. For each age group, mean and variance trend equations are examined, and for the age group 35 - 39, both the mean and variance trends equations are derived herein, and for the rest two groups only the mean trend equations are derived as the variance is constant for these two groups. For the above three age groups, the mean and variance trend is a non-linear polynomial, and the mean trend is of five, three, and first degree, while the variance trend is of fourth, zero, zero degree polynomial in time, respectively. The trend curve for the age ≥ 45 years old is strictly increasing, while trend curve for the age groups (35 - 39), or (40 - 44) is initially increasing up to 2006, or 2005, and after that they are declining up to 2014, or 2015, and finally they are increasing over the time. The derived trend models can forecast the induced abortion numbers in future. Many social educational plans related family planning are highly necessary at school/college levels to impart the adverse effects knowledge of induced abortions to women health, that may reduce the senior women's induced abortions. Some extra efforts are requisite to impart the required education on effective contraception use and family planning.

Keywords: Family Planning; Health Issue; Joint Generalized Linear Models (JGLMs); Induced Abortion; Non-Constant Variance; Senior Adults; Trends

Introduction

Senior women pregnancies and linked induced abortions are always connected with a serious public health issue [1,2]. In some countries such as USA, Sweden, New Zealand, Australia, a pre-viable fetus abortion is legal, while it is illegal in several countries over the world. For USA also, there are several state-related limitations such as gestational age restrictions, mandatory waiting periods exist, and there are approximately 50% unintended pregnancies, while 40% of the unintended pregnancies end in induced abortion, about 90% of these procedures are cleaned during the 1st trimester [3,4]. Commonly, it is safe with no complications for the countries with legal abortion, while it is highly risky for women's health for the countries with illegal abortion [3-5].

Induced abortions are greatly linked with major women's health issues, which is a common gynecological process. Despite highly advanced abortion procedures, there are some known risks and adverse effects, which should be considered in women's health issues. The induced abortion completion process can be examined easily by watching the removal of uterine contents through ultrasonography, which is used during the process. Throughout the world, approximately, 13% of maternal deaths are secondary due to induced abortions, while majority of these deaths happen in the countries with illegal abortion [5-7]. Major complications linked with induced abortions include high bleeding, an infection in the upper genital tract, sever pain, an incomplete abortion that causes salpingitis, endometritis, parametritis and oophoritis [6-9].

Senior women's induced abortions trends are studied very little in the earlier articles [1,2,10]. In women's health studies, generally, induced abortions trends are not examined using mathematical models. The word "Trend" is linked to a data set for a long time period that is termed as time series data. Trend is usually defined as the persevering and gradual movement for a long time series period. Therefore, the long term variation of a time series data for smooth upward increase, or downward decrease is termed as trend [11,12]. In practice, the trend problem derivation is really a statistical statement, and we have by no means turned the problem to a mathematical form, nor have we done away with the necessary for requisite verifications of the characteristics of the original data. The trends of induced abortions are very little studied using statistical modeling [2,10].

Aim of the Study

The current article makes an attempt to derive the induced abortions trend equations for the senior women ≥ 35 years old adopting statistical approaches of joint generalized linear models (JGLMs), which are rarely applied in the study of induced abortions literature.

Materials and Statistical Methods

Materials

The present paper considers induced abortions data for senior women (≥ 35 years old) of New Zealand from the year 2000 to 2019. The data description and their values can be found in the website link source: https://catalogue.data.govt.nz/dataset/abortion-statistics It includes induced abortions information for women ≥ 11years old with three columns that describe the data collection year, women's age, induced abortions numbers. For immediate use in the article, the data set for three age groups (35 - 39), (40 - 44) and ≥ 45 years old are given in table 4.

Statistical methods

The present study considers the senior women (≥ 35 years old) induced abortions trends of New Zealand from the year 2000 to 2019 based on the data set is given in table 4. It is identified herein that the random response abortion numbers over time for the three age groups (35 - 39), (40 - 44) and ≥ 45 is positive, homogeneous (or heterogeneous), and non-normally distributed. The data set is analyzed herein adopting the gamma distribution under JGLMs and GLMs which are neatly given in the book by Lee, Nelder and Pawitan [13] and by Das [14]. For ready reference, the gamma JGLMs is shortly reported herein.

Gamma JGLMs: The positive random variable herein is the number of induced abortions=Y_i's (say), with mean=$E(Y_i) = \mu_i$ (say), unequal variance (σ_i^2) with Var (Y_i) = $\sigma_i^2 \mu_i^2 = \sigma_i^2 V(\mu_i)$ say, where $V(\ )$ reveals the dispersion function. It is noted herein that the variance has two elements such as σ_i^2 (free of μ_i's) and $V(\mu_i)$ (depending on μ_i's). The dispersion function $V(\ )$ presents the GLM family distributions. For instance, if $V(\mu) = \mu$, it is Poisson, normal if $V(\mu)= 1$, and gamma if $V(\mu) = \mu^2$ etc. Mean and dispersion models of gamma JGLMs are as follows:

$$\eta_i = g(\mu_i) = x_i^t \beta \text{ and } \varepsilon_i = h(\sigma_i^2) = w_i^t \gamma ,$$

Where $g(\cdot)$ and $h(\cdot)$ are the GLM link functions for the mean and dispersion linear predictors respectively, and x_i^t, w_i^t are the independent explanatory variables vectors linked with the mean and dispersion parameters respectively. Maximum likelihood (ML) method is adopted to estimate mean parameters, and the restricted ML (REML) method is applied to estimate dispersion parameters, which are elaborately given in the book by Lee, Nelder and Pawitan [13].

Statistical Analysis and Results

Statistical analysis

The response senior women's induced abortion numbers of New Zealand from the year 2000 to 2019 is modelled herein using JGLMs (or GLMs) with the gamma distribution taking the transformed time t (=Year-2009) as the independent variable, sine the response variable induced abortion numbers is positive heteroscedastic (or homoscedastic). Final model is selected based on the lowest Akaike information criterion (AIC) value (within each class) that reduces both the squared error loss and predicted additive errors [15; p. 203-204]. For the age group (35 - 39), the response senior women's induced abortion numbers is heteroscedastic, while it is homoscedastic for the age groups (40 - 44) and ≥ 45 years old. For the age group (35 - 39), in the mean model t, t^2, t^3, t^4 and t^5 are included as all of them are significant, while in the variance model only t^2 and t^4 are significant, but all t, t^2, t^3 and t^4 are included due to the functional marginality rule (i.e. if a higher degree (i.e. t^4) term is significant, then all its lower degree should be included in the model) by McCullacgh and Nelder [16]. The gamma JGLM fit analysis outcomes for the senior women's induced abortion numbers for age (35 - 39) are given in table 1.

Model	**Covariate**	**Estimate**	**Standard error**	**t-value**	**P-Value**
Mean	Constant	7.441	0.0074570	997.800	< 0.0001
	t^1	-0.03867	0.0037510	-10.310	< 0.0001
	t^2	-0.003320	0.0006887	-4.820	< 0.0001
	t^3	0.0007823	0.0001638	4.776	< 0.0001
	t^4	0.00004228	0. 0000079	5.287	< 0.0001
	t^5	-0.000004751	0.0000015	-3.159	0.0016
Dispersion	Constant	-8.996421	0.7088789	-12.691	< 0.0001
	t^1	-0.290281	0.1851915	-1.567	0.1394
	t^2	0.130412	0.0523060	2.493	0.0258
	t^3	0.007087	0.0037702	1.880	0.0811
	t^4	-0.001638	0.0007268	-2.253	0.0408
AIC		204.3353			

Table 1: Gamma fitted JGLMs for the induced abortions data for the age group (35 - 39) years old.

The derived senior women's induced abortions gamma JGLMs fitted model for the age group (35 - 39) in table 1 is a data obtained model that is selected based on model fitting checking plots in figure 1. In figure 1a, JGLMs gamma fitted absolute residuals for the senior women's induced abortions for age (35-39) are plotted against the fitted value, which is nearly a flat straight line, concluding that the variance is constant with the running means. Figure 1b shows normal probability plot of the JGLMs gamma fitted induced abortions mean model for age (35 - 39) (Table 1), which does not show any lack of fit. Both these plots in figure 1 show that the derived JGLMs gamma fitted induced abortions trend model for senior women age (35 - 39) group is almost correct.

Similarly, for the age group (40 - 44), the response senior women's induced abortion numbers is homoscedastic that is modelled

Figure 1: For the JGLMs gamma fitted induced abortions models for age (35 - 39) (Table 1), the (a) absolute residuals plot against the fitted values, and (b) the mean model normal probability plot.

by adopting gamma GLM model, and the summarized results are presented in table 2. For the age group (40 - 44), in the mean model t, t^2 and t^3 are included as they are all significant.

Model	**Covariate**	**Estimate**	**Standard error**	**t-value**	**P-Value**
Mean	Constant	6.4927201	0.0123900	523.953	< 0.0001
	t^1	-0.0219757	0.0035560	-6.179	< 0.0001
	t^2	-0.0009212	0.0002886	-3.192	0.0014
	t^3	0.0002991	0.0000551	5.424	< 0.0001
Dispersion	Constant	-6.607	0.3535000	-18.69	< 0.0001
AIC		187.2467			

Table 2: Induced abortions data GLM gamma fitted results for the age group (40 - 44) years old.

The derived senior women's induced abortions GLM gamma fitted model for age (40 - 44) in table 2 is tested by model fitting diagnostic plots in figure 2. In figure 2a, absolute residuals for the GLM gamma fitted induced abortions for age (40 - 44) are plotted against the fitted value, which is nearly a flat straight line, except the two tails, indicating that the variance is constant with the running means. Note that both tails are little decreasing as some smaller absolute residuals are located at the two boundaries. Figure 2b shows normal probability plot of the GLM gamma fitted induced abortions mean model for age (40 - 44) (Table 2), which does not indicate any lack of fit. Both these plots in figure 2 show that the derived GLM gamma fitted trend model of the induced abortions for age (40 - 44) is almost correct.

Figure 2: For GLM gamma fitted induced abortions model for age (40 - 44) (Table 2), the (a) absolute residuals plot against the fitted values, and (b) the mean model normal probability plot.

Similarly, for age ≥ 45 years old, the response senior women's induced abortion numbers is homoscedastic, which is analyzed by adopting gamma GLM, and the summary outcomes are shown in table 3. For age ≥ 45 years old, in the mean model only t is included as it is only significant.

Model	Covariate	Estimate	Standard error	t-value	P-Value
Mean	Constant	3.93752	0.030801	127.838	< 0.0001
	t^1	0.01259	0.005322	2.366	0.0180
Dispersion	Constant	-3.96	0.332800	-11.90	< 0.0001
AIC		137.0885			

Table 3: Induced abortions data GLM gamma fitted results for the age group (≥ 45) years old.

The derived senior women's induced abortions for age ≥ 45 years old, GLM gamma fitted model in table 3 is tested by model fitting diagnostic plots in figure 3. In figure 3a, absolute residuals for the GLM gamma fitted of induced abortions for senior women age ≥ 45 years old are plotted against the fitted value, which is nearly a flat straight line, except the right tail, interpreting that the variance is constant with the running means. The right tail is little increasing as a larger absolute residual is located at the right boundary. Figure 3b shows normal probability plot of the GLM gamma fitted induced abortions mean model for senior women age ≥ 45 years old (Table 3), which does not present any lack of fit. Both these plots in figure 3 show that derived GLM gamma fitted trend model of the induced abortions for senior women age ≥ 45 years old is almost correct.

Figure 3: For GLM gamma fitted induced abortions model for age (≥ 45) (Table 3), the (a) absolute residuals plot against the fitted values, and (b) the mean model normal probability plot.

Analysis results

Table 1 shows the summarized JGLMs analysis outcomes of senior women's induced abortions trend for the age group (35 - 39) under JGLMs gamma fit. Gamma fitted mean model shows that the mean response of the senior women's induced abortion numbers is a fifth degree function of time "t". Note that time "t" is the transformed time, where t = (Period - 2009) (Shown in table 4). In the mean model, t ($P < 0.0001$), t^2 ($P < 0.0001$), t^3 ($P < 0.0001$), t^4 ($P < 0.0001$) and t^5 ($P = 0.0016$) are significant. In the variance model, t^2 ($P = 0.0258$) and t^4 ($P = 0.0408$) are significant, while t ($P = 0.1394$) and t^3 ($P = 0.0811$) are partially significant and they are included in the model due to the functional marginality rule by by McCullacgh and Nelder [16].

JGLM gamma fitted senior women induced abortions for age (35 - 39) mean ((35 - 39)) model (Table 1) is (35-39)

$=\exp(7.441 - 0.03867\,t -- 0.003320\,t^2 + 0.0007823\,t^3 + 0.00004228\,t^4 -- 0.000004751\,t^5)$ and the fitted mean trend values are given in table 4.

The gamma fitted senior women induced abortions for age (35-39) dispersion ($\hat{\sigma}^2$ (35-39)) model is

$\hat{\sigma}^2$ (35-39) = $\exp(-8.996421 -- 0.290281\,t + 0.130412\,t^2 + 0.007087\,t^3 -- 0.001638\,t^4)$.

Table 2 shows the summarized gamma GLM analysis outcomes of senior women's induced abortions trend for the age group (40 - 44). Gamma GLM fitted mean model shows that the mean response of induced abortion numbers for (40 - 44) is a third degree function of time "t". In the mean model, t ($P < 0.0001$), t^2 ($P = 0.0014$) and t^3 ($P < 0.0001$) are all significant.

GLM gamma fitted senior women's induced abortions for age (40 - 44) mean ((40 - 44)) model (Table 2) is (40 - 44) = $\exp(6.4927201 - 0.0219757\,t --0.0009212\,t^2 + 0.0002991\,t^3)$, and the fitted mean trend values are given in table 4.

GLM gamma fitted senior women's induced abortions for age (40 - 44) dispersion (ˆ (40-44)) is $\hat{\sigma}^2$ (40-44) = exp(--6.607).

Table 3 presents the summarized GLM gamma fitted outcomes of senior women's induced abortions trend for the age ≥ 45 years old. GLM gamma fitted mean model shows that the mean response of induced abortion numbers for the senior women age ≥ 45 years old is a first degree function of time "t". In the mean model, t ($P = 0.0180$) is only significant.

GLM gamma fitted senior women's induced abortions for age ≥ 45 mean ((≥ 45)) model (Table 2) is (≥ 45) = $\exp(3.93752 + 0.01259\,t)$, and the fitted mean trend values are given in table 4.

GLM gamma fitted senior women's induced abortions for age ≥45 dispersion ($\hat{\sigma}^2$ (≥45)) is $\hat{\sigma}^2$ (≥45) = exp(--3.96).

Year	t[1]	Abortion no. age (35 - 39)	Fitted abor. no. age (35 - 39)	Abor. no. age (40 - 44)	Fitted abor. no age (40 - 44)	Abor. no. age (≥ 45)	Fitted abor. no. age (≥ 45)
2000	-9	1823	1822.1	613	600.5	43	45.8
2001	-8	1730	1748.0	593	636.8	48	46.4
2002	-7	1715	1740.7	686	664.4	49	47.0
2003	-6	1846	1765.6	692	683.2	38	47.6
2004	-5	1916	1798.7	721	693.8	58	48.2
2005	-4	1773	1822.9	687	697.0	47	48.8
2006	-3	1777	1827.3	691	693.9	42	49.4
2007	-2	1814	1807.4	667	685.8	58	50.0
2008	-1	1754	1764.5	675	674.2	54	50.6
2009	0	1692	1704.5	674	660.3	50	51.3
2010	1	1649	1635.7	655	645.6	50	51.9
2011	2	1593	1567.4	605	631.1	55	52.6
2012	3	1506	1507.9	590	618.1	61	53.3
2013	4	1451	1464.4	637	607.4	44	53.9
2014	5	1384	1442.3	611	600.2	56	54.6
2015	6	1483	1445.6	598	597.2	65	55.3
2016	7	1443	1476.8	602	599.6	52	56.0
2017	8	1562	1536.4	584	608.6	45	56.7
2018	9	1679	1621.7	660	625.4	50	57.4
2019	10	1707	1723.8	634	651.9	70	58.2

Table 4: Original and fitted induced abortions data for the age groups (35 - 39), (40 - 44), (≥ 45).

Discussions and Conclusion

The article has developed senior women's (≥35 years old) induced abortions trends of New Zealand from the year 2000 to 2019 adopting statistical JGLMs/ GLMs under the gamma distribution. Commonly, trend equations are obtained assuming variance is constant [11,12]. When the variance is unequal, it is important to develop both the mean and variance trends jointly, which are rarely studied in time series analysis. Best of our knowledge, senior women's induced abortions trends are rarely studied in the women's health literature adopting statistical methods [2,10]. Here the response senior women's induced abortions variance is unequal for age (35 - 39), while it is constant for the age groups (40 - 44) and ≥ 45 years old, and they should be analyzed by using JGLMs/GLMs. The current article has studied first time of senior women's induced abortion trends adopting advanced statistical models. Moreover, final models are accepted with stable estimates, as their standard errors are very small (Table 1-3), and based on minimum AIC value, graphical diagnosis (Figure 1-3). The research should have a higher confidence on the present derived findings.

From figure 4a and 4b and table 4, it is seen that the senior women's induced abortions trend for age (35 - 39), or (40 - 44) of New Zealand from the year 2000 - 2019 is initially increasing from 2000 to 2006, or 2000 to 2005, and after that it is declining up to 2014, or 2015, and after that both are increasing. From figure 4a and 4b (also from table 4), it is seen that original and fitted values are very close to each other. The current findings imply that the impacts of family planning education and contraception use are not satisfactorily effective for the senior women (35 - 44) in New Zealand.

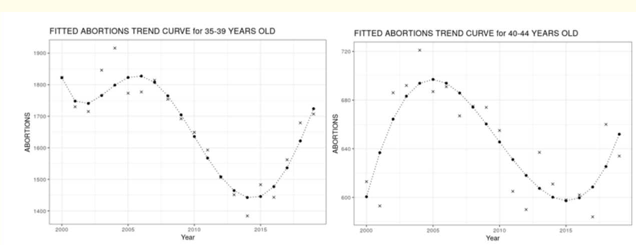

Figure 4a   Figure 4b

Figure 4: Scattered plot of the original observations, fitted values and the smooth fitted mean trend curves for the age group (a) (35 - 39) and (b) (40 - 44).

From figure 5 and table 4, it is seen that the senior women's induced abortions trend for ≥ 45 years old of New Zealand from the year 2000 to 2019 is strictly increasing from 2000 to 2019. The present findings imply that the impacts of contraception use and family planning education are not well effective for the senior women for ≥45 years old in New Zealand. This situation is completely different from the senior women age group (35 - 44). Further studies are required to locate the casual factors linked to the increase of induced abortions for the senior women ≥ 35 years old in New Zealand. Similar situations, or many more adverse situations may be found in many developing, or under developing countries. Some research studies are to be performed for such countries.

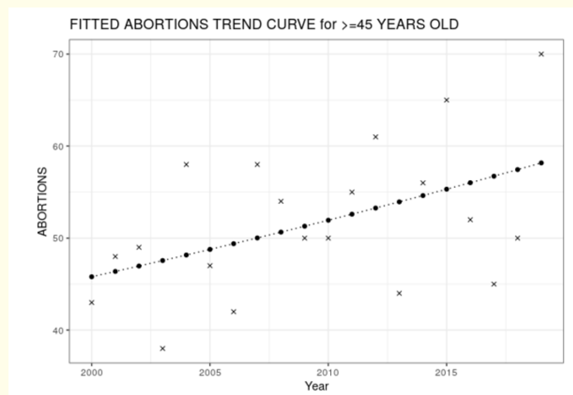

Figure 5: Scattered plot of the original observations, fitted values and the smooth fitted mean trend curves for the age group ≥ 45 years old.

There is no similar study for the senior women's induced abortions trends of New Zealand, so the current outcomes cannot be compared with the earlier studies. The current derived outcomes and models are clearly tested by figure 1-5. Here it is found that the fitted values are very close to the original data. The preset outcomes will help the researchers and the Government for interpreting the future senior women's induced abortions in New Zealand. Based on the interpretation from the current paper, the Government can take requisite actions. The family planning education is to be continued in New Zealand, and other developing, or under developing countries.

Acknowledgement

The author is very much grateful for helping statistical analysis and interpretations to Dr. Jinseog Kim, Department of Applied Statistics, Dongguk University, Gyeongju, Republic of Korea.

Bibliography

1. Kapp N., *et al*. "Medical abortion in the late first trimester: A systematic review". *Morbidity and Mortality Weekly Report* 65.4 (2016): 1-66.
2. Ioannis T., *et al*. "Trends in Induced Abortions in Greece: A Cross-sectional Study". *Journal of Pediatric and Adolescent Gynecology* 33.2 (2020): 149-152.
3. Niinimaki M., *et al*. "Comparison of rates of adverse events in adolescent and adult women undergoing medical abortion: population register based study". *British Medical Journal* (2111): 342.
4. Bjartling C., *et al*. "The association between mycoplasma genitalium and pelvic inflammatory disease after termination of pregnancy". *BJOG: An International Journal of Obstetrics and Gynaecology* 117.3 (2010): 361-364.
5. Larsson PG., *et al*. "Incidence of pelvic inflammatory disease after first-trimester legal abortion in women with bacterial vaginosis after treatment with metronidazole: a double-blind, randomized study". *American Journal of Obstetrics and Gynecology* 166.1-1 (1992): 100-103.
6. Carlsson I., *et al*. "Complications related to induced abortion: a combined retrospective and longitudinal follow-up study". *BMC Women's Health* 18 (2018): 158.
7. World Health Organization DoRHaR. Safe abortion: technical and policy guidance for health systems". Second edition (2012).
8. Brian G Bell FS., *et al*. "A systematic review and meta-analysis of the effects of antibiotic consumption on antibiotic resistance". *BMC Infectious Diseases* 14 (2014): 13.
9. Penney GC TM., *et al*. "A randomised comparison of strategies for reducing infective complications of induced abortion". *BJOG: An International Journal of Obstetrics and Gynaecology* 105.6 (1998): 599-604.
10. Jones RK., *et al*. "Trends in abortion in the United States". *Clinical Obstetrics and Gynecology* 52.2 (2009): 119-129.
11. Montgomery DC., *et al*. "Introduction to Time Series Analysis and Forecasting, John Wiley and Sons Inc., New Jersey (2016).
12. Shumway RH and Stoffer DS. "Time Series Analysis and Its Applications: With R Examples, 4th Edition, Springer International Publishing AG, Switzerland (2017).
13. Lee Book Lee Y., *et al*. "Generalized Linear Models with Random Effects (Unified Analysis via H–likelihood) (Second Edition)". Chapman and Hall, London (2017).
14. Das RN. "Robust response surfaces, regression and positive data analyses". Chapman and Hall, London, (2014).
15. Hastie T., *et al*. "The Elements of Statistical Learning (Second edition)". Springer-Verlag, New York (2009).
16. McCullagh P and Nelder JA. "Generalized linear models". Chapman and Hall, London (1989).

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