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Re-Examining Fertility Trends and Patterns among Black South African Women Using the Reverse Survival Method

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***Abstract*:** Fertility levels have been declining in South Africa, with no effort made to re-examine and establish the validity and differentials of prevailing (existing) trends and patterns retrospectively. The South African Census and Survey data (1996–2016) data was used to re-examine (backwards project) fertility levels (patterns), trends and differentials among Black South African women. These are secondary cross-sectional data collected at different points in time in South Africa, using a similar methodology. These were performed using the Reverse–Survival Method (RSM) indirect estimation technique, controlling for the study sample. The RSM is appropriate in estimating and tracking temporal changes in fertility patterns retrospectively, up to fifteen years backsword. The study confirmed that fertility levels were low and declining over the years. TFR declined from 4.7 to 2.5, while the GFR declined from 157 to 83 live births per 1, 000 women (1982–2016). Although converging, subgroup differentials revealed fertility rates closer to replacement levels, and seemed to be stalling in the urban areas and less traditional provinces (e.g. Gauteng and Western Cape). Internal and external validity checks were also provided by the rate of overlapping periods revealed in the study. The study established the validity of existing patterns. Also, proved that the RSM is a robust and reliable method, providing accurate checks, new dimensions and understanding of the transitions among the study sample and in South Africa. The method is appropriate in the study of fertility transition as findings contribute to knowledge, crucial to programme and policy developments in the country.

***Keywords*:** Fertility transitions, Reverse–Survival Method, backwards projecting, internal validity check, retrospective, overlapping periods

Background

In South Africa, earlier studies suggest a continuum in fertility decline, starting much earlier ahead of most countries in the Southern region (Anderson, 2003; Caldwells in

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1993; Moultrie and Timaeus, 2003; Palamuleni *et al.*, 2007; Stats SA, 2011; Rossouw *et al.*, 2012; Makgeledisa, 2017). Fertility levels started declining in the 1950s and became more pronounced in the 1960s in the country (Rossouw *et al.*, 2012; Stats SA, 2011). The rate declined from 6.0 in the 1950s to 4.3 in the 1980s and was 3.3 in the 1990s (Rossouw *et al.*, 2012; Moultrie and Timaeus, 2003). In 2011, the rate was about 2.51 children and at a current estimate of 2.34 in 2022, South Africa currently has the lowest Total Fertility Rate (TFR) in Southern Africa (Stats SA, 2022).

Also, fertility levels began to decline at different times and rates among different population groups in South Africa, suggesting variations by demographics. Early studies suggest that the rate declined more slowly for the Black African population when compared to any other population group in the country (Swartz, 2003). For example, the fertility level of the Black African population group "decreased from a high of 6,8 to a low of about 3,9 between the mid-1950s and the early 1990s. Although it continues declining, African fertility is still substantially higher than that of the other racial groups" (Swartz, 2003:2). The rate was at 2.8 in 2011 and during the same period, the white (1.7) and Indian/Asian (1.8) population group had already recorded a remarkable decline in fertility below replacement levels (Stats SA, 2015). Therefore, at the rate of 2.8 in 2011, the level of fertility among Black African women remained the highest among all population groups in South Africa (ibid). These are so, with the provincial pattern differentials reflecting the unique characteristics prevailing in each province (Stats SA, 2015; Palamuleni *et al.*, 2007).

Yet, being the furthest fall in fertility witnessed in the sub-region, the drop in fertility levels in South Africa has been broadly described as remarkably sharp, but not universally acknowledged (Moultrie and Timaeus 2003; Swartz, 2003). According to Rossouw *et al.* (2012), these assertions are true, as "given South Africa's state of development and the resources invested in promoting family planning, one may have expected a steeper decline" (Rossouw *et al.*, 2012: 3). These developments points to a drag in knowledge and presents a debate pertaining to fertility trajectories in the country. In these lights, the need for a study re-examining and establishing the validity and differentials of existing patterns in South Africa has become inevitable, especially by disaggregation. Fertility changes and needs should be assessed by disaggregation in order to understand and narrow inequality gaps.

Therefore, the question the study seeks to answer is: what are the validity of existing trends and patterns of fertility among black South African women? Given the size of the study sample (i.e. black South African women), is the technique adopted in the study appropriate in the understanding of the fertility transitions of the study sample and that of South Africans at a broader level? Statistical evidence indicates that Black South Africans make up over 80% of the South African population (Stats SA, 2011). Therefore, carrying out a study of this nature will not only help in understanding and validating their fertility trajectories (patterns) but would also result in a broader understanding of the national patterns (Rossouw *et al.*, 2012).

Against these backdrops, this study re-examines the trends, levels and differentials in fertility among Black South African women in South Africa. These were done using census survey data collected between 1996 and 2016 in the country. Specifically, the study looked at the total and general fertility rates (TFR and GFR) indicators, including their differentials retrospectively using an indirect estimation method. Results were then compared with those obtained from other published sources, derived using other methods in some cases. It is envisaged that doing these will bring about a new dimension to existing knowledge of fertility decline in South Africa. It will also result in a broader understanding, leading to informed programme and policy development in the country.

Methods

Study Data and Quality Issues: The Census and Survey data collected between 1996 and 2016 in South Africa were used to re-evaluate and assess the validity of existing fertility trends, patterns, and differentials among Black South African women in the country. These are secondary cross-sectional design data collected at four different points in time (de facto) in South Africa, using a similar methodology. Questions used to obtain data from all sources are also similar, making the data comparable and suitable for a nationally representative study. The census data was collected in 1996, 2001 and 2011, while the South African Community Survey (CS) data was collected in 2016. The major key input variables of the RSM method are the age and sex variables. Therefore, given the fact that what determines the consistency of the RSM fertility estimates is the quality of the data that are used. As long as no major issues are found in the data by age and sex across data collection operations, the RSM will return consistent fertility estimates. More so, the issue of the under-enumeration of young children found in many censuses and surveys (in both statistically advanced and not advanced countries) is not a concern in South Africa. In these lights, the quality of these data sets was examined in studies such as Stats SA (2017) and Stats SA (2023) and was found to be of good quality and hence, fit for use in this study.

Study Design and Analysis: Adopting a quantitative research design approach, the Reverse–Survival method (RSM) indirect estimation techniques were adopted in the reconstruction and analysis of fertility trends and patterns among black South African women. These were done by specifically looking at the Total and General Fertility rate indicators (TFR and GFR), including their differentials retrospectively. Results obtained were then compared with estimates obtained from other sources in some cases. This helped in providing validities and in doing so, also established the fitness and robustness of using the RSM technique in estimating fertility trends and patterns. Also, with a view of adding a new dimension to the study of fertility transition in the country (Sibanda and Zuberi, 1999; Opiyo and Levin, 2008). The RSM is a method not well and commonly used in the South African context. As an indirect estimation method, the RSM is proven to be appropriate and has the benefit of re-estimating (backwards projecting) fertility levels and trends, especially in countries with a paucity of data (Avery *et al*., 2013; Spoorenberg, 2014; Dubuc, 2009; Opiyo and Levin, 2008). The method estimates annual births from the census age distribution and then estimates total fertility from these counts by indirect standardization. It is relatively easy to use and can be used to derive estimates for up to fifteen years backwards (ibid). It can be applied to any dataset with basic variables such as age and sex provided.

The task of carrying out the RSM technique was done using the description and Excel templates provided by Moultrie and Timaeus (2013). In this template, the ASFRs are specified as inputs produced by interpolation, and the GFR is relevant as it is produced by the RSM as an interstitial metric on the way to producing the TFRs. All the data used in the study has variables appropriate to use in the application of the RSM method. In the study, projections and discussions were done at national and sub-group levels (i.e. province and place of residence) to unveil their differentials in the study periods. Specifically, in applying the RSM, some data distribution and values are required. These include the tabulations of the population (of both sexes) aged 0 to 14, by single years of age, tabulations of the female population aged 15 to 64 by five-year age group, cohort survival probabilities, Lx, for children aged 0 to 14 of both sexes and the survivorship ratios, 5Lx-5/5Lx for adult women for each of the three five-year periods preceding the inquiry (Ong'aro, 2014). Also, a single age-specific fertility distribution that is assumed to apply to the entire period covered by the estimates is also required in the case of producing the TFR (ibid). Data were generated and analysed using STATA software (version 14) and findings were expressed in rates.

Study Limitation: The RSM model is not designed to directly produce its own Age Specific Fertility Rate (ASFR), as such a weakness. The ASFRs reflected by the model are inputs - produced by the RSM model by interpolation and hence not an output produced by the model. As such cannot be used in the production of charts, used in the report. Also, early studies have insisted that the model does not give room to explicitly (properly) adjust for migration and mortality, especially at the subnational population levels (province and rural-urban areas), hence a concern. This is so, given the fact that the South African migration and mortality patterns differ a lot by disaggregation. Therefore has material bearing on the results produced, and as such, cannot be ignored. According to the study, significant bias will consequential if migration flows are large and migrants have different fertility from the rest of the population (Ong'aro, 2014). Also, the RSM sometimes has a weakness of overestimation in some cases as shown in Table 1 of the findings, where some TFR estimates seem to increase slightly over time – instead of decline in certain provinces.

Results

Trends, Patterns and Differentials in TFR

Trends in the Projected TFR (1996, 2011 and 2016): Table 1 presents the trends in the total fertility rate (TFR) estimates of the study sample by province, place of residence and South Africa, applying the RSM in 2011. The results show that TFR was 3.1 in 1997, declining to 2.9 in 2005 and then to 2.7 in 2011 in South Africa. The TFR in Western Cape was 2.1 children per woman in 1997, while those in KZN and Gauteng were 2.9 and 2.0 in 2003 and 2006, respectively. The TFR in Limpopo were 3.2 children per woman in 2011. As the years increased, the levels of TFR declined, indicating a declining pattern (transition) in the projected period. The TFR in the less traditional provinces and urban areas was closer to or below replacement levels in some cases, compared to that of the more traditional provinces and the rural areas. These trends were consistent for all projected data points (1996 and 2016) as shown in the Appendix.

Patterns and Differentials of Projected TFR

Patterns and Overlapping Years Differentials: Figure 1 presents the projected patterns in the TFR estimates of the study sample, applying the RSM, 1996–2016. The results show overall declining patterns projected back to 1982. The rate declined from about 4.7 children per woman in the early 1980s to 3.1 in 1996 and was 3.0 in 1998. The level further declined slightly to 2.7 children per woman in 2011 and 2.5 children per woman in 2016, reflecting an overall declining fertility pattern among the study sample in the study period.

Table 1: Trends in the total fertility rate (TFR) estimates by province, rural/urban residence and South Africa, applying the RSM, 2011

	W/Cape	*E/Cape*	*N/Cape*	*F/State*	*KZN*	*N/West*	*Gauteng*	*M/langa*	*L/popo*	*Urban*	*Rural*	*SA*
1997	2.1	3.8	2.8	2.8	3.7	2.9	2.0	3.4	3.7	2.3	4.2	3.1
1998	1.9	3.7	2.8	2.6	3.5	2.7	1.9	3.2	3.5	2.2	4.0	2.9
1999	1.8	3.6	2.7	2.6	3.4	2.7	1.8	3.1	3.4	2.1	3.9	2.8
2000	1.8	3.5	2.9	2.8	3.4	2.9	1.9	3.3	3.5	2.2	4.0	2.9
2001	1.8	3.3	2.7	2.7	3.2	2.9	1.9	3.1	3.3	2.1	3.8	2.7
2002	1.7	3.2	2.6	2.6	3.0	2.7	1.8	2.8	3.1	2.0	3.5	2.6
2003	1.8	3.3	2.7	2.6	2.9	2.7	1.8	2.8	3.1	2.0	3.5	2.6
2004	1.9	3.6	2.7	2.8	3.0	2.8	1.9	2.9	3.2	2.1	3.6	2.7
2005	2.0	3.9	2.8	2.9	3.2	3.0	1.9	3.1	3.5	2.2	3.9	2.9
2006	2.0	3.8	2.8	2.9	3.1	3.0	2.0	2.9	3.5	2.2	3.8	2.8
2007	2.2	3.8	2.8	2.9	3.1	3.1	2.1	3.0	3.5	2.3	3.9	2.9
2008	2.3	3.7	2.8	2.9	3.1	3.2	2.2	3.0	3.4	2.4	3.8	2.9
2009	2.4	3.4	2.8	2.8	3.0	3.2	2.3	3.0	3.3	2.4	3.6	2.9
2010	2.4	3.1	2.7	2.8	2.8	3.1	2.3	2.8	3.2	2.4	3.4	2.8
2011	2.5	3.0	2.7	2.7	2.7	3.1	2.3	2.8	3.2	2.4	3.2	2.7

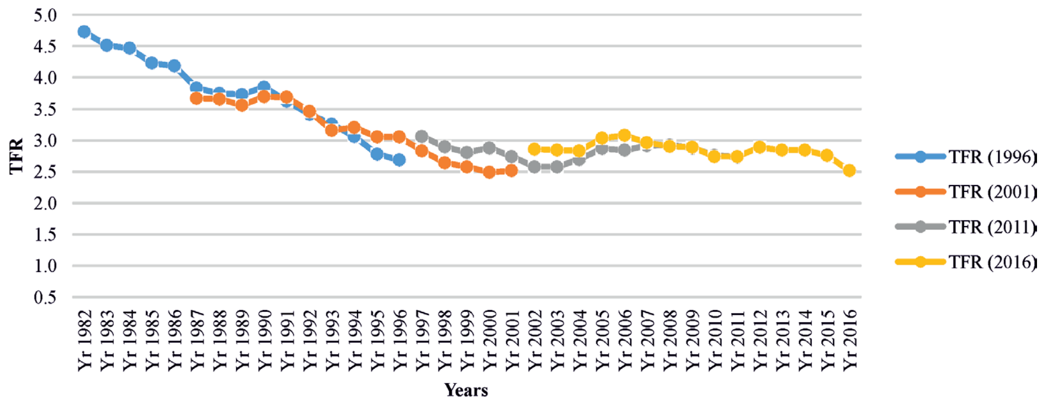

Figure 1: Patterns in the TFR estimates, applying the RSM, 1996–2016

Figure 2 presents the differentials in the TFR estimates of the study sample in the overlapping years, applying the RSM, 1996–2016. The results show that the differentials were highest (0.39) in the year 2000 and lowest (0.01) in the years 2009 and 2011. With the exception of 1991 and 1992, the differentials reported a negative decline between 1987 and 1993 and in the years 2008 and 2010. Overall, the results show that the overlapping year differentials were very insignificant, confirming the accuracy and validity of early patterns, therefore supporting the notion of both internal and external validity check capabilities and also, the robustness of using the RSM technique in the estimation of fertility trends and patterns (levels).

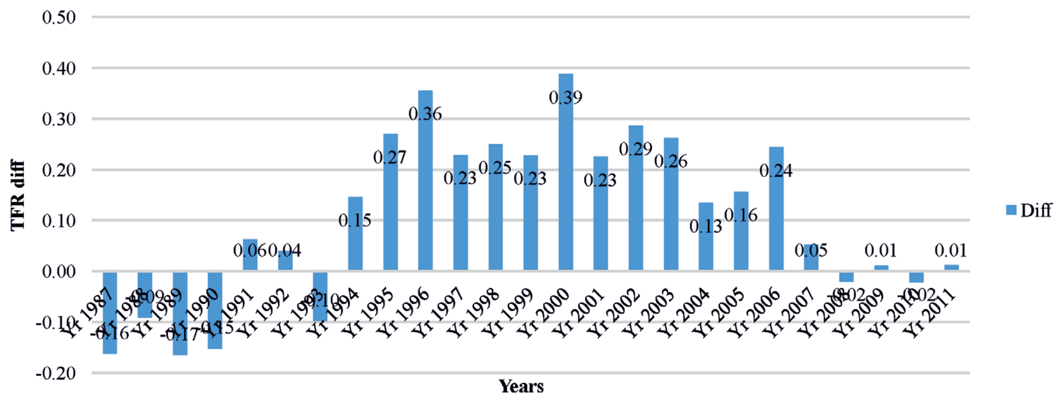

Figure 2: Differentials in the TFR estimates in the overlapping years, applying the RSM 1996–2016

Subgroup Differentials in the Projected TFR

Figure 3 presents the patterns in the TFR estimates of the study sample by place of residence (rural/urban), applying the RSM, 1996–2016. The trends presented in the figure suggest that fertility levels in the study sample had been declining in both types of places of residence in South Africa. The projected TFR of women in rural areas was estimated to be 6.2 children per woman in 1982, declining to 3.8 in 2011 and then to 2.8 children per woman in 2016. The estimate for urban areas was 3.3 children per woman in 1982, declining to 2.5 in 1991 and slightly further to 2.3 children per woman in 2016. The rates therefore followed the traditional declining pattern of fertility levels experienced in South Africa, projected back to 1982. The results also presented a variation in the TFR observed between the urban and rural areas, with the rural fertility rates (patterns) slightly higher than the urban fertility rates. A decline in the rates has also been occurring in a converging manner, with the convergence more pronounced among those in the rural areas, compared to those in the urban areas in the earlier years. The pattern also seems to be stalling and approaching replacement levels in the urban areas, especially in the closer years.

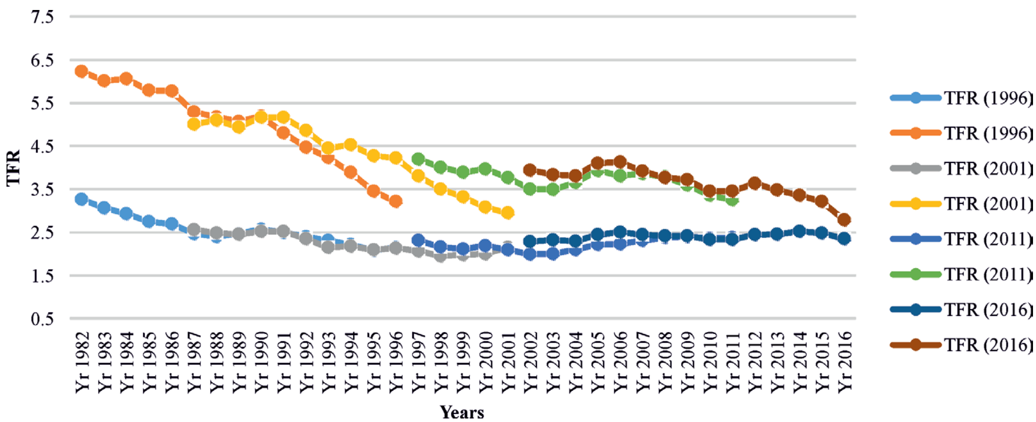

Figure 3: Patterns in the TFR estimates by place of residence, applying the RSM, 1996-2016

Figure 4 presents the patterns in the TFR estimates of the study sample by selected provinces (Western Cape, Gauteng and Limpopo), applying the RSM, 1996–2016. The results show that Limpopo province had a higher estimated TFR compared to Western Cape and Gauteng provinces. The levels of estimated TFR of these women in Limpopo were as high as 6.3 children per woman in the early eighties. The rate declined to 3.0 in 2003 and was 2.7 children per woman in 2016. The levels were 3.0 and 2.7 per woman in the Western Cape and Gauteng in 1982, decreasing slightly to 2.4 and 2.3 in 2016. These patterns indicate that the fertility levels of these women also vary by province in the country (Palamuleni *et al.*, 2007). It also seems to be stalling and approaching replacement levels in the less traditional provinces, especially in the closer years.

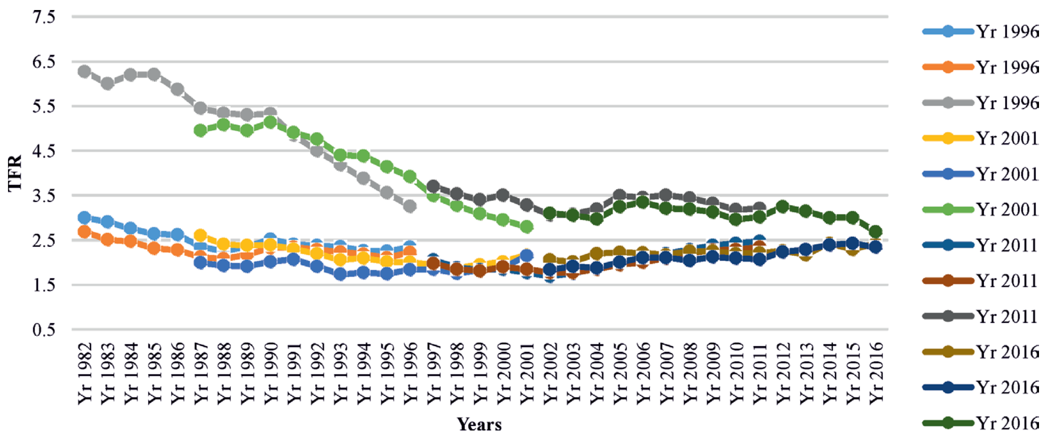

Figure 4: Patterns in the TFR estimates by selected provinces (Western Cape, Gauteng and Limpopo), applying the RSM, 1996–2016

Comparison of Reverse–Survival Method (RSM) Estimates by various Methods

Comparison of TFR Levels by various Methods, 2011: Figure 5 presents a comparison of TFR levels of the study sample by various methods in 2011. The different methods presented very close TFR estimates, ranging between 2.5 and 2.8 children per woman in the study period, therefore indicating that the projected TFR obtained using the RSM technique is fairly accurate and comparable to those obtained using other methods. The result also confirms that the rates correspond well, irrespective of each method being subjected to a different methodological approach, i.e. procedures and assumptions (Ong'aro, 2014). These findings further illustrate the strength of the RSM technique in estimating fertility levels and in providing good indicators of fertility trends and patterns in the study period.

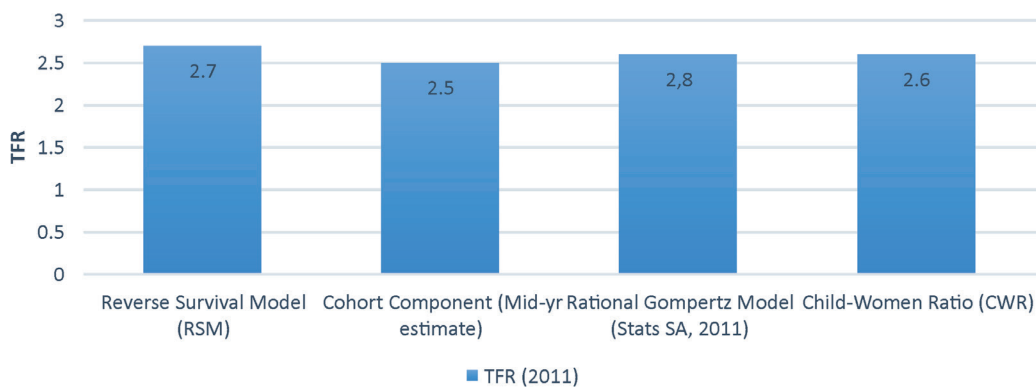

Figure 5: Comparison of TFR levels by various methods, 2011

Source: Stats SA (2011) a are performed using SPECTRUM, and calculated TFR from Census 2011

Comparison of TFR Trends and Patterns by various Models (1982–2016): Figure 6 presents a comparison of TFR patterns of the study sample by various models across the projected period, of 1982–2016. The results show that the estimated RSM patterns were comparable (close in resemblance) and remarkably consistent with those of other patterns by various models. The results show that the patterns corresponded and followed a similar declining trajectory over the years, therefore supporting the notion that fertility levels had been declining not only among Black South African women but also among all women in South Africa in general. The results also further support the notion that the RSM technique provides good indicators of fertility levels and trends in the study period.

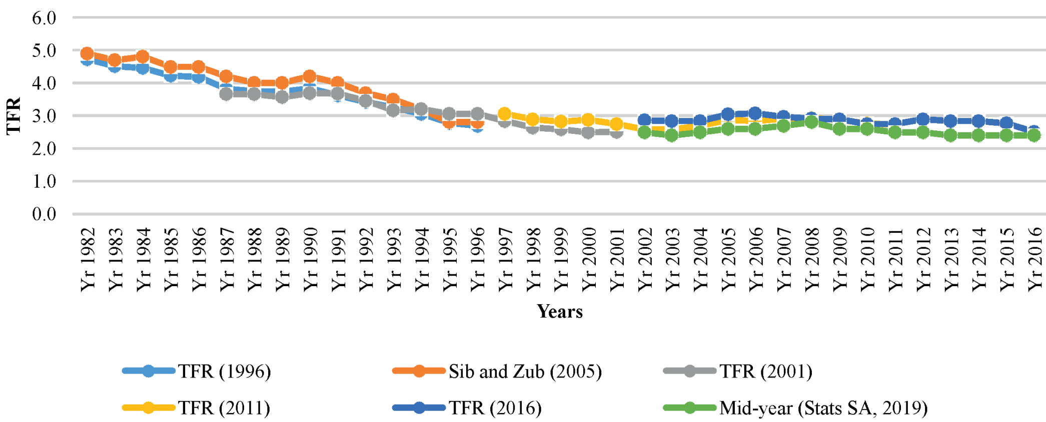

Figure 6: Comparison of TFR trends and patterns by various models across the projected period, 1982-2016

Source: Stats SA (2019); Sibanda and Zuberi (2005); and calculated TFR using 1996–2016 data

Trends, Patterns and Differentials in GFR

Trends in the Projected GFR (1996, 2011 and 2016): The GFR is produced by the RSM as an interstitial metric on the way to producing the TFRs. Table 2 presents the trends in the general fertility rate (GFR) estimates of the study sample by province, type of place of residence and South Africa, applying the RSM in 2011. The results show that GFR declined from 97 to 91 live births per 1, 000 women from 1997 to 2005 and was 89 live births per 1, 000 women in 2011 in the study period. The GFR of these women was 70 live births per 1, 000 women in the Western Cape in 1997, while the rate was 93 and 102 live births in KZN and Limpopo provinces in 2002 and 2001, respectively. The GFR of those women in the rural areas were greater than those in the urban areas and also decreased as the year increased. These trends were consistent for all projected data points (1996 and 2016) as shown in the Appendix.

Table 2: Trends in the General fertility rate (GFR) estimates by province, rural/urban place and South Africa, applying the RSM, 2011

Year	*W/Cape*	*E/Cape*	*N/Cape*	*F/State*	*KZN*	*N/West*	*Gauteng*	*M/langa*	*Li/po*	*Urban*	***Rural***	***SA***
1997	70	116	88	88	117	93	65	109	117	76	128	97
1998	64	110	86	82	110	86	61	104	111	71	122	92
1999	63	106	85	80	107	86	59	99	107	69	118	89
2000	63	104	90	85	107	92	62	104	110	71	120	91
2001	60	97	86	83	101	90	60	98	102	67	114	86
2002	58	94	83	81	93	85	57	89	96	64	106	81
2003	60	99	85	81	91	85	58	89	96	65	106	81
2004	64	107	86	85	94	89	60	91	99	68	111	85
2005	69	115	88	90	101	95	64	98	109	72	121	91
2006	70	114	88	89	98	93	66	94	108	73	118	90
2007	77	113	89	90	102	99	69	95	109	76	120	93
2008	80	111	89	92	101	101	73	96	107	78	118	94
2009	83	104	89	89	98	101	76	96	104	79	113	93
2010	85	96	87	87	93	98	76	90	100	78	106	89
2011	86	92	87	85	90	99	78	90	101	79	103	89

Patterns and Differentials in the Projected GFR

Patterns and Overlapping Yar Differentials: Figure 7 presents the patterns in the GFR estimates of the study sample, applying the RSM, 1996–2016. The projected pattern shows that the GFR of these women was 152 live births per 1, 000 women in the early eighties. The rate dropped to 83 live births in 2016 for the study period and indicates a declining trend generally among these women in South Africa.

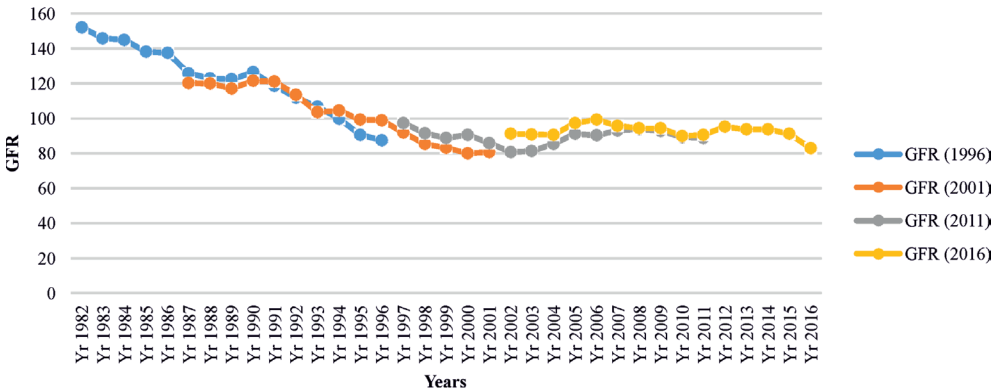

Figure 7: Patterns in the GFR estimates, applying the RSM, 1996–2016

Figure 8 presents the differentials in the GFR estimates of the study sample in the overlapping years, applying the RSM, 1996–2016. The differentials ranged from rates of 0.5 to 11.4 in the study period. With the exception of 1991 and 1992, the results show that the rates experienced a negative decline between 1987 and 1993. Overall, the graph shows that the differentials were very insignificant, indicating the accuracy of the estimated GFR, and further proving the robust nature and appropriateness of using the RSM technique in the measure of GFR over time.

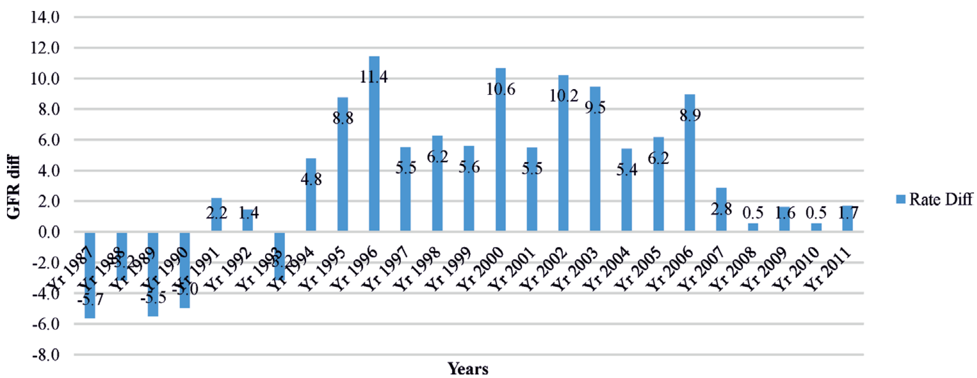

Figure 8: Differentials in the GFR estimates in the overlapping year, applying the RSM, 1996- 2016

Subgroup Differentials of the Projected GFR: Figure 9 presents the patterns in the GFR estimates of the study sample by type of place of residence, applying the RSM, 1996–2016. The trends follow the traditional declining pattern of the general fertility rate experienced among women in South Africa. The rates in the rural areas were higher when compared to those in the urban areas. The GFR of those residing in the rural areas was estimated to be 194 live births per 1, 000 women in 1982, declining to 93 live births in 2016. The estimate was also 109 live births per 1, 000 women in 1982, declining to 76 live births in 2016 in the urban areas. The pattern presented notable declining and converging patterns, with the difference being more pronounced in the early years, compared to the later years between the two areas in the study period. Patterns in the urban areas also seem to be stalling, compared to patterns in the rural areas.

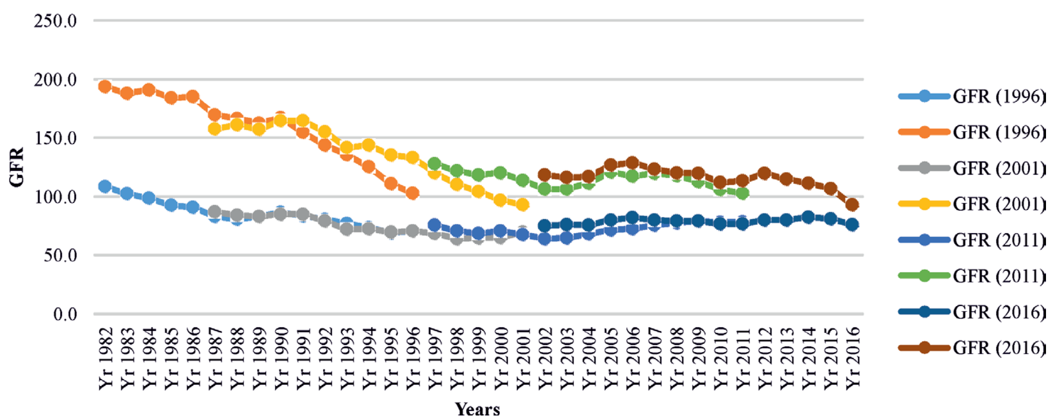

Figure 9: Patterns in the GFR estimates by type of place of residence, applying the RSM, 1996–2016

Figure 10 presents the patterns in the GFR estimates of the study sample by selected provinces (Gauteng, Western Cape and Limpopo), applying the RSM, 1996–2016. The GFR estimates were 196 live births per 1, 000 women in 1982, declining to 88 live births per 1, 000 women in 2016 in Limpopo, while the rate was 91 live births per 1, 000 women in 1982, declining to 88 live births per 1, 000 women in 2016 in Gauteng. These patterns suggest that less developed (metropolized) provinces such as Limpopo had a higher GFR compared to the more developed provinces such as the Western Cape and Gauteng. These trends suggest a declining and converging pattern in each province over the years, with the convergence being more pronounced in the closer years.

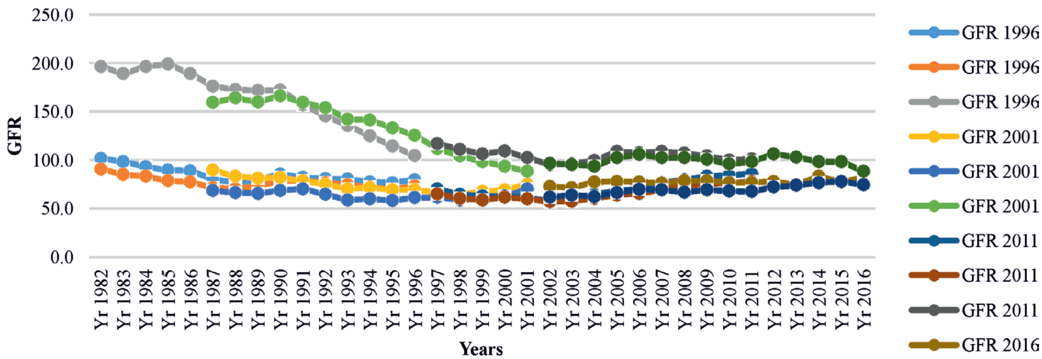

Figure 10: Patterns in the GFR estimates by selected provinces (Gauteng, Western Cape and Limpopo) applying RSM, 1996–2016

Discussion

This study uses the Reverse–survival method (RSM) indirect estimation technique to retrospectively re-examine the prevailing (existing) trends and patterns of fertility levels among Black South African women. These were done in order to establish their validity and accuracy (consistency) among the study sample. This also helped in establishing the fitness and robustness of using the technique in estimating past fertility trends and patterns in the country. In doing these, adding a new dimension to the study of fertility transition in the country.

Projected back to 1982, the examination of the total fertility rate (TFR) revealed trajectories, indicating an overall declining pattern among the study sample. Findings from the study suggest that the TFR dropped from 4.7 children per woman in the early 1980s to 2.5 children per woman in 2016. Earlier studies in South Africa and beyond (Anderson, 2003; Stats SA, 2011; Caldwells in 1993; Moultrie and Timaeus, 2002/3; Houle *et al.*, 2016; Palamuleni *et al.*, 2007; Norville *et al.*, 2003; Udjo, 2005) had found these declining patterns to be consistent. Specifically, Sibanda and Zuberi (1999) noted that this had been so "since the 1980s" (Sibanda and Zuberi, 1999:2).

Also, in applying other methods, Stats SA (2011) found consistency and noted that the levels of TFR have been declining in the country since the apartheid era (Stats SA, 2011). Furthermore, Moultrie and Dorrington (2004) found that fertility levels were declining among African women in South Africa at almost similar rates and insisted that they were lower compared to any other sub–Saharan African countries (Moultrie and Dorrington 2004; Moultrie and Timaeus, 2003). By using the 1998 DHS data, Palamuleni *et al.* (2007) also found fertility levels to be declining and to be generally low at a rate of three (3) births per woman in South Africa (Palamuleni *et* *al.*, 2007). The authors associated these developments with marriage incidence issues such as high divorce rates, remarriage, single parenthood and late marriage rates (ibid). Furthermore, Anderson (2003) argued that these patterns were true, reflecting the general declining desire for children by women in South Africa. More so, in using various datasets and not controlling for any population group, Norville *et al.* (2003) concluded that fertility levels were declining around the world. In all, these studies provide good comparisons, suggesting the accuracy of the projected fertility levels (indicators) by using the RSM in the study periods.

Although with a remarkably sharp decline, early studies such as Anderson (2003), Moultrie and Timaeus (2002), and Rossouw *et al.* (2012) argued that, given the human and other resources invested in promoting reproductive health (family planning), including the level of socio-economic development of the country, one should have expected a steeper decline in fertility levels among women in South Africa (ibid). Although not universally acknowledged, the notion does present a debate around the issue of fertility transitions in the country (Swartz, 2003; Rossouw *et al.*, 2012; Moultrie and Timaeus, 2003). Other studies have associated the declining patterns in fertility levels in South Africa with a series of factors. For example, several studies discussed the impact of HIV/AIDS on fertility levels (Anderson, 2003; Palamuleni *et al.*, 2007; Rossouw *et al.*, 2012), leading to a 10% fertility decline, compared to other causes in South Africa (Anderson, 2003). Other studies around the world such as those by Ong'aro (2014), Spoorenberg (2014), Avery *et al.* (2013), Dubec (2009), Geoff (2004), Lima *et al.* (2018), etc., have acknowledged the robustness in using the RSM or similar technique in estimating TFR estimates, especially in less developed countries with a paucity of data (Ong'aro (2014; Spoorenberg, 2014).

Overlapping period differentials revealed insignificant rates, ranging between 0.01 and 0.39 among these women, with negative values reported in some years in the study period. In so doing, confirms the accuracy and builds confidence in existing patterns in the country, and also establishes the internal and external validity check capabilities of the RSM technique. In support of this notion, Opiyo and Levin (2008) in a study in Kenya wrote that "the rates for overlapping periods provide both internal and external validity checks that heighten confidence in the overall results" (Opiyo and Levin, 2008:1). Also, Cagatay (2006) found insignificant overlapping differentials in his study in Turkey.

In addition, subgroup differentials by place of residence (rural/urban areas) present trends consistent with the traditional declining patterns of fertility levels experienced in the regions in South Africa, with the rural fertility levels slightly higher than the urban fertility levels. As such, indicate variations by place of residence as suggested by earlier studies (Stats SA, 2011). This pattern is consistent, as studies have argued that women in urban areas are more likely to have a lower number of children, as they are more exposed to the idea of family planning, smaller family size, the practice of late marriage and modern values (Kalmijn, 2007). On the other hand, women in rural areas are also more likely to be uneducated and unemployed (ibid). They are also more likely to continue childbearing at later ages, compared to urban women; hence, the higher number of children (Swartz, 2003). Other reasons behind this are also well documented by earlier studies in Southern Africa.

The patterns also showed that convergence waves were more pronounced in the rural areas, compared to the urban areas. These patterns suggest that fertility transition (decline) is a continuum, setting in earlier in the urban areas and still catching up faster in the rural areas. It also seems to be stalling, approaching or below replacement levels (in some cases) among these women in the urban areas. Studies have found these declining patterns to be consistent in sub–Saharan Africa. For example, Stats SA in reference to Moultrie and Dorrington (2008) wrote that fertility decline seems to be stalling since the 1990s in South Africa, especially in the urban areas (Stats SA, 2011). Specifically, in applying the Reverse–survival method in Kenya, Ong'aro (2014) wrote that fertility levels in Kenya are on a declining trajectory, "with women in rural areas having more children compared to those living in urban areas" (Ong'aro, 2014:47). The difference in TFR between the rural and urban areas has been associated to factors leading to rural-urban divides and others reasons well documented by earlier studies in the country (Camlin *et al.*, 2004; Palamuleni *et al.*, 2007; Swartz, 2003; etc.).

Trends by province (Western Cape, Gauteng, and Limpopo) in the study period also presented a declining and converging pattern consistent with earlier findings, with Limpopo province (being a more traditional province) having a higher TFR, compared to provinces such as Western Cape and Gauteng (being less traditional provinces) in the study period. These patterns also indicate an early onset of fertility transition among those women in the less traditional provinces, compared to the more traditional provinces. Consistent with earlier assertions, the pattern also suggests that fertility levels may be stalling (Stats SA, 2011; Moultrie and Dorrington, 2008) and seem to be approaching or below replacement levels (in some cases) in provinces such as Western Cape and Gauteng. This then supports the notion that fertility transitions (levels) of the study sample also vary by province in the country (Palamuleni *et al.*, 2007; Stats SA, 2011). For example, early studies such as those by Moultrie and Timaeus (2002), Moultrie and Dorrington (2004), Palamuleni *et al.* (2007) and Stats SA (2011) specifically found that TFR was generally higher among women in provinces such as Limpopo and Eastern Cape, and lowest among women in the provinces of Gauteng and Western Cape (ibid).

Also, in using similar methods and controlling for selected characteristics, Sibanda and Zuberi (1999) found a consistency in the declining patterns of fertility levels in South Africa, insisting that this has been so "since the 1980s" (Sibanda and Zuberi, 1999:2), thus confirming the declining nature of fertility levels across demographics in South Africa (ibid). A study in India also found that fertility levels were varying within the states of India and argued that it was not shocking due to a significant difference in fertility corridors across major states in the country (Chatterjee, 2017). Moultrie and Timaeus (2002) associated provincial differences with racial composition and other socio-economic inequalities created by the past apartheid regime in the country. Specifically, Stats SA (2011) argued that these patterns "may reflect the different levels of socio-economic status as well as the dominance of specific population groups in provinces" (Stats SA 2011:5). Furthermore, Moultrie and Dorrington (2004) noted that they reflect the compositions and the level of urbanisation prevailing in each province (Moultrie and Dorrington, 2004). Other studies (Opiyo and Levin, 2008; Ong'aro, 2014; Dubec, 2009) also found these patterns to be consistent in their studies among women in Kenya and the UK.

A comparison of RSM levels by those obtained using various models in 2011 presented close TFR estimates, ranging between 2.5 and 2.7 children per woman, thus presenting rates fairly accurate and comparable to those of other methods projected for Black South African women in 2011. The results show that the rates were fairly consistent and corresponded well, "independent of the data source considered" (Lima *et al.*, 2018:1) or procedures and assumptions applied (Ong'aro, 2014). Also, a comparison of RSM patterns by various models across the projected periods (1982 and 2016) revealed patterns that are close in resemblance and remarkably consistent across periods, as the patterns correspond, following a similar declining trajectory over the projected years. Overall, this supports the notion that fertility levels have been declining not only among the study sample in the study period but in South Africa in general. In comparing different patterns from different methods, Dubec (2009) in a similar study in the UK, found consistency and insignificant differences in fertility patterns, therefore insisting that these methods are at least accurate (Dubec, 2009).

The GFR is relevant as it is produced by the RSM as an interstitial metric on the way to producing the TFRs. Estimates of the general fertility rate (GFR) among the study sample revealed a rate of 152 live births per 1, 000 women in the early eighties. The study found that the rate dropped to about 89 live births in 2011 and was about 83 live births per 1, 000 women in 2016. Empirical evidence suggests that these trajectories are also consistent, revealing the declining patterns of GFR common among women in Southern Africa. For example, in analysing the DHS data using another method, the SADHS (2016) report found these patterns to be consistent in their study in South Africa. Also, in applying the RSM technique in Kenya, Ong'aro (2014) found the GFR to be high and on a declining trajectory among women in general in the country. According to the author, the "rate varied from a high of 207 in 1999 to a low of 137 births per thousand women" (Ong'aro, 2014: 40).

Differentials in estimated levels also revealed insignificant differences in rates, ranging between 0.5 and 11.4, which further illustrates the accuracy and appropriateness of the RSM method. Subgroup differentials by place of residence and province suggest traditional declining and converging patterns observed earlier in the study (i.e. with the TFR indicator), with the rate in the rural areas being higher. The less metropolized (developed) provinces such as Limpopo also have a higher GFR, compared to the more metropolized provinces such as the Western Cape and Gauteng. These patterns further support the assertion that fertility transitions experienced an earlier onset among women in the urban and less traditional provinces, compared to those in the rural and more traditional provinces (Stats SA 2011). This further supports the notion of regional variations in GFR, as earlier studies have also shown (e.g. Ong'aro, 2014). The converging manner of decline observed in the study period suggests that fertility transition is still a continuum, following trajectories observed earlier in the study. As such, it further validates the impression that the RSM is an appropriate and robust method of estimating the GFR, and contributes further to the study and understanding of fertility transitions in the country. In all, Lima *et al*. (2018) wrote that in the generation of indicators, different methods and data sources generate differing levels of fertility estimates with some degree of validity. Therefore, countries should concern themselves with the quality of data in use, rather than dwelling on methods (Lima *et al*., 2018).

Conclusion

The study found that the TFR and GFR estimates derived using the RSM technique were accurate and consistent with expectations. The TFR and GFR maintained consistent decreasing patterns over the years among the study sample. These patterns have also been fairly consistent (in trajectory), even when disaggregated by selected characteristics or compared with findings obtained using another method. These findings illustrate the strength of the RSM technique in estimating fertility levels and in providing good indicators in the study period. As such, the overall notion of validity checks, robustness and fitness is embedded in the technique. Although largely unexploited, the study concludes that the technique adds a new dimension to existing knowledge of fertility decline. Therefore, appropriate in the study and understanding of the overall fertility transitions at different disaggregation levels and in South Africa.

Ethical Issues and Conflicts of Interest: The study used secondary data already collected, processed and available on request. Also, the study design is quantitative in nature and, therefore has no risk of undue disclosure and other ethical considerations. Consequently, ethics clearance was granted for the study by the Basic and Social Sciences Research Ethics Committee (BaSSREC) of the North West University. Also, permission to use the SADHS 2016 data for this study was obtained from ICF Macro Inc. accordingly. In these lights, the author has no conflicts of interest to declare in carrying out the study.

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Appendix

Table 3: Trends of total fertility rate (TFR) estimates by province, rural/urban place and South Africa, applying the RSM, 1996

Year	*W/Cape*	*E/Cape*	*N/Cape*	*F/State*	*KZN*	*N/West*	*Gauteng*	*M/langa*	*Li/po*	*Urban*	*Rural*	*SA*
1982	3.0	5.9	4.7	4.4	5.1	4.7	2.7	5.3	6.3	3.3	6.2	4.7
1983	2.9	5.8	4.5	4.1	4.9	4.3	2.5	5.1	6.0	3.1	6.0	4.5
1984	2.8	5.7	4.4	4.0	4.9	4.1	2.5	5.0	6.2	2.9	6.1	4.5
1985	2.6	5.4	4.1	3.7	4.5	3.9	2.3	4.7	6.2	2.8	5.8	4.2
1986	2.6	5.5	4.0	3.5	4.5	3.8	2.3	4.7	5.9	2.7	5.8	4.2
1987	2.4	5.0	3.6	3.3	4.2	3.5	2.1	4.3	5.5	2.5	5.3	3.8
1988	2.3	4.9	3.6	3.3	4.0	3.6	2.1	4.1	5.3	2.4	5.2	3.7
1989	2.4	4.8	3.8	3.3	3.9	3.7	2.2	4.1	5.3	2.5	5.1	3.7
1990	2.5	5.0	3.7	3.3	4.0	3.6	2.3	4.2	5.3	2.6	5.2	3.8
1991	2.4	4.6	3.6	3.1	3.8	3.4	2.3	3.9	4.9	2.5	4.8	3.6
1992	2.4	4.2	3.4	2.9	3.6	3.3	2.3	3.6	4.5	2.4	4.5	3.4
1993	2.4	4.0	3.2	2.7	3.5	3.1	2.2	3.5	4.2	2.3	4.2	3.3
1994	2.3	3.6	3.1	2.5	3.3	2.9	2.2	3.3	3.9	2.2	3.9	3.1
1995	2.2	3.2	2.8	2.2	2.8	2.8	2.1	2.9	3.6	2.1	3.5	2.8
1996	2.3	2.9	2.7	2.2	2.8	2.7	2.2	2.7	3.3	2.2	3.2	2.7

Table 4: Trends of total fertility rates (TFR) by province, rural/urban place and South Africa, applying the RSM, 2016

Year	*W/Cape*	*E/Cape*	*N/Cape*	*F/State*	*KZN*	*N/West*	*Gauteng*	*M/langa*	*Li/po*	*Urban*	*Rural*	*SA*
2002	2.1	4.0	2.7	2.6	3.8	2.9	1.8	3.0	3.1	2.3	3.9	2.9
2003	2.0	4.0	2.8	2.7	3.7	2.8	1.9	2.9	3.0	2.3	3.8	2.8
2004	2.2	4.2	2.7	2.5	3.6	2.8	1.9	2.9	3.0	2.3	3.8	2.8
2005	2.2	4.5	2.8	2.8	3.8	3.0	2.0	3.0	3.3	2.4	4.1	3.0
2006	2.2	4.5	2.8	2.8	3.8	3.0	2.1	3.0	3.3	2.5	4.1	3.1
2007	2.2	4.3	2.7	2.7	3.6	2.9	2.1	2.8	3.2	2.4	3.9	3.0
2008	2.2	4.0	2.7	2.6	3.5	3.0	2.0	2.8	3.2	2.4	3.8	2.9
2009	2.2	3.9	2.7	2.5	3.4	2.9	2.1	2.9	3.1	2.4	3.7	2.9
2010	2.2	3.5	2.5	2.4	3.2	2.8	2.1	2.7	3.0	2.3	3.4	2.7
2011	2.2	3.4	2.7	2.5	3.3	2.8	2.1	2.7	3.0	2.3	3.5	2.7
2012	2.3	3.6	2.9	2.5	3.3	3.0	2.2	2.9	3.2	2.4	3.6	2.9
2013	2.2	3.3	2.9	2.4	3.3	2.9	2.3	2.8	3.1	2.5	3.5	2.8
2014	2.4	3.1	2.8	2.4	3.2	3.0	2.4	2.8	3.0	2.5	3.4	2.8
2015	2.3	2.9	2.7	2.3	3.1	2.8	2.4	2.8	3.0	2.5	3.2	2.8
2016	2.4	2.5	2.7	2.2	2.7	2.7	2.3	2.5	2.7	2.3	2.8	2.5

Table 5: Trends of general fertility rate (GFR) estimates by province, rural/urban place and South Africa, applying the RSM, 1996

Year	*W/Cape*	*E/Cape*	*N/Cape*	*F/State*	*KZN*	*N/West*	*Gauteng*	*M/langa*	*Li/po*	*Urban*	*Rural*	*SA*
1982	101	180	150	144	163	152	91	173	196	109	194	152
1983	98	179	146	134	158	139	85	165	189	102	188	146
1984	93	176	144	132	157	135	83	165	197	98	191	145
1985	89	170	132	122	148	126	78	154	199	92	184	138
1986	89	176	129	117	149	126	77	155	189	91	185	137
1987	80	159	118	108	137	114	72	141	176	83	170	126
1988	76	155	118	108	130	119	70	137	173	81	167	123
1989	80	152	122	109	127	120	73	136	171	83	163	123
1990	86	160	118	109	132	120	79	139	172	87	167	126
1991	82	147	116	101	125	113	79	129	157	84	155	119
1992	81	135	109	95	118	107	77	121	146	80	144	112
1993	80	128	103	88	114	100	74	115	136	77	136	107
1994	77	114	98	82	107	96	72	108	125	74	125	100
1995	77	101	91	73	93	91	70	96	115	69	111	91
1996	80	93	88	73	90	90	73	90	105	71	103	88

Table 6: Trends of general fertility rate (GFR) estimates by province, rural/urban place and South Africa, applying the RSM, 2016

Year	*W/Cape*	*E/Cape*	*N/Cape*	*F/State*	*KZN*	*N/West*	*Gauteng*	*M/langa*	*Li/po*	*Urban*	*Rural*	*SA*
2002	73	115	86	81	120	89	62	97	97	75	118	91
2003	71	118	90	83	116	88	64	93	95	76	116	91
2004	77	125	87	79	114	87	62	93	94	76	117	91
2005	78	135	91	89	123	95	67	96	103	80	127	97
2006	78	138	91	89	123	95	70	98	106	82	129	99
2007	76	134	89	85	117	93	69	92	102	80	123	96
2008	78	127	89	83	114	96	67	92	103	79	120	94
2009	78	124	87	82	114	93	69	94	101	79	120	94
2010	77	113	82	79	108	91	68	89	96	77	112	90
2011	77	111	89	81	110	91	67	89	98	77	113	91
2012	78	118	96	83	110	100	72	96	106	80	120	95
2013	75	112	97	79	110	95	74	94	103	80	115	94
2014	83	106	93	78	110	98	77	93	99	82	112	94
2015	77	98	89	76	106	91	78	92	99	81	107	91
2016	82	84	87	72	91	86	75	81	88	76	93	83aA