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PROBABILITIES OF DYING BETWEEN 15 AND 60 YEARS OF AGE (45q15) IN SURINAME AND ITS MAIN REGIONS, 2004-2012
Death Distribution Methods

Belo Horizonte, MG
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Death Distribution Methods

Dissertation presented to the Ph. D course in Demography of the Centre of Development and Regional Planning of the Faculty of Economic Sciences of the Federal University of Minas Gerais. The dissertation is a partial requirement to obtain the doctor degree in Demography. Supervisor: Prof. Dr. Bernardo Lanza Queiroz

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GLOSARY

AHI – Age Heaping Index

ASFR- Age Specific Fertility Rates

BH - Benneth and Horiuchi

BHP- Broken Hill Proprietary Company Limited

BOG – Bureau Openbare Gezondheidszorg (Department of Public Health of the Ministry of Health of Suriname)

CBB – Centraal Bureau voor Burger Zaken (in Suriname)

CBS - Centraal Bureau voor de Statistiek (in Netherlands)

CDR – Child Dependency ratio

DDM´s – Death Distribution Methods

GBS – General Bureau of Statistics

GGB - General Growth Balance

GGB-SEG- Hybrid General Growth Balance and Synthetic Extinct Generation

FDT - First Demographic Transition

HAD – Human Development Atlas

HiAP - Health in all policies

ICSI – Index of Concentration on Single Ages

IMF- International Monetary Fund

IW – Whipple´s Index

$\frac{k1}{k2}$ - $k1$ Coverage of the first census; $k2$ coverage of the second census

km^2 - Square Kilometers

NBW - Nieuw Burgelijk Wetboek

ODR - Old Age Dependency Ratio

PAHO - Pan America Health Organization

PHC- Primary Health Care Foundation

$_{n}q_{x}$ - Function probability of dying

$_{45}q_{15}$ - Probability of dying between 15 and 60 years

SBW - Surinaams Burgelijk Wetboek (Surinamese Citizen Lawbook)

SDV - Standard Deviation

SEG - Synthetic Extinct Generation

S.Z.F. - Staats Zieken Fonds (Governmental Fund for the sick)

TDR - Total Dependency Ratio

TFR - Total Fertility Rate

UN - United Nations

WHO - World Health Organization

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RESUMO

Na maioria dos países em desenvolvimento, omissão nos censos populacionais e omissões no sistema de registo vital são comuns. Portanto, é importante avaliar a integralidade da cobertura do registro censitário e de óbitos e realizar os ajustes necessários. Os métodos de distribuição de morte (DDM) são um dos três métodos para avaliar a qualidade dos dados e estimar a mortalidade de adultos. DDM compararam a distribuição dos óbitos por idade com a distribuição etária dos vivos e fornecem o padrão etário da mortalidade em um período de referência definido.

Nesta dissertação, o objetivo principal é avaliar a qualidade do registro de óbitos e enumeração dos censos populacionais para estimar a mortalidade de adultos no Suriname e seus principais regiões entre 2004 e 2012. Foram aplicados os métodos de distribuição de morte usando diferentes segmentos etários ***incluindo*** ou ***excluindo*** uma alta proporção de migração de pico por sexo para o Suriname e as suas regiões. Nós produzimos estimativas do grau de cobertura do registro de óbitos, ajustamos os dados e produzimos estimativas de mortalidade de adultos por sexo e para cada uma das regiões. A análise dos métodos de distribuição de morte por vários segmentos etários no estudo do Suriname e seus principais regiões é necessário por causa da presença de migração interna e internacional e porse tratar de uma população pequena.

A qualidade dos dados populacionais do Censo 2004 e de 2012 do Suriname e suas principais regiões foram considerados bons. No que diz respeito a cobertura do registro de óbitos, a qualidade para o país varia de razoável a boa. Os resultados das probabilidades de morte são para a população masculina e feminina nos intervalos $[0.1950, 0.2329]$ e $[0.1153, 0.1324]$, respectivamente. A zona costeira urbana e rural costeira mostram para a população masculina e feminina perto do nível de mortalidade observado no país. No entanto, a população masculina e feminina da área rural interior tem valores médios abaixo ou acima dos valores da região litoral costeira e urbano ou rural, dependendo do método de distribuição de morte e os segmentos de idade aplicados. A probabilidade média de morrer entre os 15 e 60 anos de idade para a população masculina e feminina na área rural interior, por diferentes métodos de distribuição morte e segmentos etários, está no intervalo $[0.1315, 0.2067]$ e $[0.1047, 0.1568]$, , respectivamente.

ABSTRACT

In most developing countries, omission in population censuses and vital registration system omissions are common. Therefore, it is important to assess completeness of coverage of the census and death registration to make some adjustments accordingly. The death distribution methods (DDM) are one of the three advanced methods for evaluating data quality or otherwise estimating adult mortality. DDM compare the distribution of the deaths by age with the age distribution of the living and furthermore provide the age pattern of mortality in a defined reference period.

In this dissertation, the main objective is to evaluate the data quality of the death counts and population enumeration to estimate adult mortality in Suriname and its main regions between 2004 and 2012. We applied the death distribution methods using different age segments ***including*** or **excluding** a high proportion of peak migration by sex for Suriname and its central regions. We produced estimates of completeness of death counts coverage, adjusted the data and produce adult mortality estimates. The analysis of the death distribution methods by various age segments in the study of Suriname and its main regions is necessary because of the presence of internal and international migration in this small scale population.

The quality of the population data of Census 2004 and 2012 of Suriname and its main regions is considered to be good. With respect to the death count, the quality for the country varies from reasonable to good. The results of ${}_{45}q_{15}$ indicates probabilities of dying for the male and female population in the intervals $[0.1950, 0.2329]$ and $[0.1153, 0.1324]$, respectively. The urban coastal area and rural coastal area show for a male and female population ${}_{45}q_{15}$ close to those on a country level. However, the ${}_{45}q_{15}$ for a male and female population of the rural interior area have on average values below or above the values of the urban coastal and or rural coastal area depending on the death distribution method and the age segments adopted. The average probability of dying between 15 and 60 years of age for the male and female population in the rural interior area by different death distribution methods and age segments is in the interval $[0.1315, 0.2067]$ and $[0.1047, 0.1568]$, respectively.

1. INTRODUCTION

In most developing countries, a complete registration of deaths to determine mortality estimates does not exist (Timaeus, 1991; Hill, Choi, and Timaeus, 2005; Hill, 2000). Researchers mainly encounter various difficulties such as incomplete vital registration, imprecise censuses, and misreporting of age at death or age of the living (Hill, 2000; Hill, You and Chou, 2009; United Nations, 1983; Bhat 1990; Leone, 2014); Queiroz & Sawyer, 2012; Lima & Queiroz, 2014). Therefore, due to the lack of vital statistics, in most developing countries it is impossible to apply standard direct methods to produce specific mortality and or life table estimates, such as the probability of dying (${}_n q_x$) at different ages (Luy, 2010).

Within this context, the research questions in this dissertation are:

1. What are the quality of the death counts and population data and the completeness of death registration in Suriname and its central regions, by sex between the Census 2004-2012?

2. What are the adult mortality levels (${}_{45} q_{15}$) for the country and its central regions, by methods, age segments, and sex after correction of the population data (Census 2004 and 2012) and death counts between 2004 and 2012?

To answer the research questions, the first primary objective of this dissertation is to evaluate and analyze the data quality of death registration and the population of Suriname and its central regions. The second objective is, to determine the completeness of death reporting in Suriname and its main areas in the most recent period (2004 – 2012). Therefore, the specific objectives are:

- Evaluate the data quality of the population and death count data for Suriname and its main regions using selected age heaping indexes;

- Application of the selected Death Distribution Methods (DDM´s) for estimating the adult mortality in Suriname and its central regions;

- To determine and analyze the indicators of adult mortality by sex for Suriname and its central areas, based on some age segments of the population which will either ***include*** *or* ***exclude*** age groups with peak adult migration;

- Compare and analyze the results of adult mortality ($_{45}q_{15}$) after the application of the DDM´s for Suriname and its main regions between methods, within methods, by sex and age segments;

- To discuss the mortality differences by sex, age segments, and region;

In the process to answer the research questions the first step is to evaluate and analyze age data errors (coverage errors, failure to record age, and misreporting of age) of the population and the deceased. Moreover, are applied the DDMs which are direct methods of measures for mortality and represent the conventional or classical approach to demographic estimation (Timaeus, 1991). The completeness of death registration in Suriname and its central regions will be determined by using the following death distribution methods (DDMs). Firstly, the General Growth Balance (GGB) proposed by Hill (1987) and secondly the Synthetic Extinct Generations (SEG), the Benneth-Horiuchi method (1981;1984). Furthermore, the combined GGB-SEG method (Hill, You and Choi, 2009) will be used. Lastly, the General Growth Balance (GGB) method for migration or populations open to migration will be presented (Bhat, 2002; Hill and Queiroz, 2010), but not used in this dissertation.

These five DDMs methods were developed to apply to non-stable populations. The advantage compared to former methods is that the old methods[1] assume stability[2] and the newer ones do not. The distribution of deaths by age is compared with the age distribution of the living population, which in turn will afford the age array of mortality in a defined reference period (Hill, You & Choi, 2009). Additionally, the GGB method (Hill, 1987) and the method of Benneth-Horiuchi (1981; 1984) assume that the coverage of deaths and population does not vary with age. Furthermore, these methods assume no experience of net migration and proper declaration of the age of the people and the age of deaths. The GGB and SEG methods have an additional assumption that is, the coverage of the population does not vary over time. Moreover, the combined GGB-SEG method consists of applying the GGB method to estimate

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[1] The old methods are the Growth Balance (Brass, 1975) and the method of Preston *et.al* (1980)

[2] A population is stable if three conditions prevail for a long enough period: 1) the growth rate in the annual number of births is constant; 2) age specific death rates are constant; age specific rates of net migration are zero (Preston, Heuveline and Guillot, 2001)

the change in Census coverage, adjusting the expected change and then using the SEG method. The GGB method for migration (Bhat, 2002; Hill and Queiroz, 2010) that is applied to populations affected by substantial net migration requires the same assumptions as the GGB (Hill, 1987) method.

The second step, after analyzing the quality of mortality data is to estimate the probability of dying between 15 and 60 years (${}_{45}q_{15}$). The likelihood of dying between 15 and 60 years (${}_{45}q_{15}$) is an indicator that is used to measure adult mortality. The choice of ${}_{45}q_{15}$ is done because it is a summary measure of adult mortality for the death distribution methods (Hill, 2000).

For small population countries such as Suriname, which suffers from the effect of international and/or internal migration (emigrants and immigrants) the impact of relocation is strongly notable in the growth rate of the population in some periods[3]. Therefore, it is necessary to consider migration effects in the estimation of adult mortality. According to GBS (2006), the results of the pattern of survival ratios for both sexes of the age groups 5-9 up to 25-29[4] are not acceptable from censuses between 1980- 2004. The explanation given is that also migration should have had an effect on the survival ratios, besides the mortality effect.

The estimates of adult mortality in the country and regional level are of paramount interest for Suriname. Mainly because of the small possibility of conducting registration in the hinterland of the country. Furthermore, the four category of problems identified by GBS concerning registration of vital statistics[5], and the presence of international net and net internal migration (positive or negative) are of great importance. Another justification for estimating adult mortality regionally in Suriname is in the scope of improvement of national planning on quality control data of the death. Moreover, establishments of more CBB offices in remote areas and the continuous improvement of access to health services in all parts of the country

[3] The exponential growth rate of the population of Suriname from census 1972 to census 1980 was - 0.06634., based on Census data of General Bureau of Statistics (GBS) of Suriname. According to data of the United Nations (World Population Prospects 2012) the growth rate of the population of Suriname was negative (-0.429) from 1970-1975(a period of peak international migration in Suriname (CBB)).

[4] Survival Ratios Census 1980-2004 for age groups 5-9, 10-14, 15-19, 20-24 and 25-29 are 0.7910, 0.7526, 0.7624, 0.8366 and 0.9492, respectively (GBS, 2006)

[5] The four categories of problems identified by GBS for generating the yearly vital statistics are: 1) problems related to the use of the acquired data, 2) unambiguous situations of registration of birth and death, 3) timeliness and 4) not completeness of the registration

is necessary. According to Kibele (2012), between regions of one country, significant differences in probabilities of dying and life expectancy may exist. Likewise, mortality can be differentiated by the socio-economic status of the population.

Another important fact to study mortality in Suriname and its central regions is that the country has diverse ethnic compositions, cultural characteristics and areas of tiny and disperses population. The study of small areas by sex results in the rare occurrence of death in single ages and thus affects the outcome of the adult mortality indicators. Investigating adult mortality in Suriname is interesting within the context of its characteristic in South –America namely being part of the Guyana's with the smallest populations and not being culturally part of the Latin America but of the Caribbean. The adult mortality study of the central regions in Suriname is also relevant because there exist few mortality studies in these areas, and the health services and infrastructure are different in the three regions. The best health infrastructure and services are in the capital Paramaribo, part of the urban coastal area.

It is clear that the differences in regional development, population density, and infrastructure concerning the presence of CBB registration offices for birth and death might have a significant effect on the estimation of probabilities of dying by sex in the various regions of Suriname. Considering some socio-economic characteristics of Suriname we observe differences between the major areas. The urban coastal area has the highest Human Development Index[6] of 0.715, followed by the rural coastal area with a value of 0.688 and the rural interior area with 0.599 (HAD, 2013). With respect to a significant social characteristic in Suriname for 2006 and 2009, the average year of schooling[7] for the urban coastal area, the rural coastal area, and rural interior area presents the values of 9.4 years, 8.28 years and 5.03 years, respectively (HAD, 2013). The Multidimensional Poverty Index[8] of 2009/ 2010 in Suriname also shows that the urban coastal area (0.009) presents better results than the rural

[6] The Human Development Index (HDI) is a summary measure of human development. It measures the average achievements in a country in three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living **(Source: GBS)**.

[7] Mean years of schooling is defined as the average number of years of education received by people ages 25 and older in their life time based on education attainment levels of the population converted into years of schooling based on theoretical durations of each level of education attained **(Source MICS 3 AND MICS4).** In Suriname it takes between 12 and 14 years to complete the secondary senior school, depending on the school type and considering no repetition of class (Ministry of Education and Science of Suriname).

[8] The Multidimensional Poverty Index (MPI) allows to identify the poor, excluded and vulnerable group of population and to measure the level of poverty and deprivation of the vulnerable group using dimension indicators. The MPI identifies overlapping deprivations at the household level across the same three dimensions as the Human Development Index (living standards, health, and education) and shows the average number of poor people and deprivations with which poor households contend **(Source: MICS 4)**

coastal area (0.014) and rural interior area (0.098). The HAD (2013) shows that for the economic indicator Gross National Income per capita[9] for 2009 (GBS) the best result is for the urban coastal area (7521 USD), followed by the rural coastal area (6321 USD) and the rural interior area (6340 USD). Regarding the percentage of the population using an improved sanitation facility in 2010, the urban coastal area, rural coastal area and rural interior area has the 98.05%, 95.66%, and 60.33%, respectively[10]. The percentage of the population using an improved water drinking source was in 2010 for the urban coastal area, rural coastal area, and rural interior area 98.25%, 97.6%, and 81.67%, respectively[11].

All these indicators presented here resume in their one way the differences in the social and economic development of the central regions in Suriname. The region with the best results for the indicators is the urban coastal area followed by the rural coastal area and the rural interior area.

Therefore, the hypothesis of this study is that there will be differences as well in the probability of dying ${}_{45}q_{15}$ and consequentially in adult mortality by main regions and sex. To see the difference between male and female ${}_{45}q_{15}$ in this dissertation, the ratio of the male to the female probability of dying between 15 and 60 years is used. To observe the differences of ${}_{45}q_{15}$ between the methods the comparison is made on the different age segments by sex and for Suriname and regions.

In Suriname, currently, the actual estimation of life expectancy is conducted without the quality control of death counts (GBS, 2011). Moreover, the existence and gradually expansion of civil registration systems in all districts as well as the international and internal migration have an effect on the quality of mortality data. Therefore, this study using DDM´s is of paramount interest for Suriname, because the ${}_{45}q_{15}$ will be estimated after evaluation of data quality of the population and the death counts. Altogether, this dissertation will contribute to the demographic research regarding the assessment of data quality of mortality

[9] Gross National Income per capita is defined as the sum of value added by all resident producers in the economy plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad, divided by midyear population. Value added is the net output of an industry after adding up all outputs and subtracting intermediate inputs **(Source: GBS)**

[10] Ministry of Social Affairs and Housing- Multiple Indicator Cluster Survey 4

[11] Ministry of Social Affairs and Housing- Multiple Indicator Cluster Survey 4

in less developed countries (South – America and the Caribbean) and small populated countries with the presence of international net and internal net migration. This study also provides the information of sensitivity of the application of the DDM´s in a country with primary regions of different socio-economic development and areas of tiny scale.

The results presented in this dissertation concerning the evaluation of the quality of death counts reveal that the death numbers of Suriname vary from precise to less accurate and to acceptable. According to GBS, the population data of Census 2004 and 2012 also indicate to be reasonable[12]. After applying the GGB, SEG, Hybrid GGB-SEG methods by different age segments different results are observed for the three methods adopted regarding the adjusted probability of dying ${}_{45}q_{15}$ on country level and central regions about the unadjusted ${}_{45}q_{15}$.

The application of the Hybrid GGB-SEG method for the male and female population for different selected age segments including or excluding age groups of peak migration presents higher values for ${}_{45}q_{15}$ in comparison with the GGB and SEG method. This is in the case in nearly all the age segments compared to the results of the adopted GGB method for Suriname and its central regions. It is clear that the choice of the age segments for the calculation of the probability of death between 15 to 60 years, ${}_{45}q_{15}$ using the Hybrid GGB-SEG method, results in big or small differences regarding the GGB method. The differences in the values of ${}_{45}q_{15}$ after application of these two methods depend on the choice of the age segments and the migration pattern of the region in study.

For the urban coastal area, rural coastal area, and for Suriname for the male and female population the values of ${}_{45}q_{15}$ are lower for the SEG method than for the GGB method using age segments excluding a high proportion of migration. For the rural interior area for the male population the values of ${}_{45}q_{15}$ are much higher for the SEG method than for the GGB method for age segments excluding age groups with a high proportion of migration. Furthermore, for the female population, the results in the rural interior show small differences for the SEG method in comparison with the GGB method. Likewise, for some age segments excluding peak migration there is a higher and for others a lower difference. As Hill, You and Choi (2009) mentioned the GGB and SEG method are very sensitive to net migration. The

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[12] Whipple´s Index for Census 2004 was respectively for male and female, 100.4 and 102.0; Whipple´s Index for Census 2012 was respectively for male and female, 101.76 and 101.72 (GBS, 2004 and 2012)

SEG method is less sensitive to age misreporting or differential coverage by age than the GGB method. Increasing or decreasing coverage of deaths by age affects GGB more than SEG (Hill and Choi, 2004). Consequently, the results of lower or higher values of ${}_{45}q_{15}$ for, the different age segments and methods applied can be better understood. Even the GGB as the SEG method gives an improvement over unadjusted data (Hill and Choi, 2004). On the results of the Hybrid GGB-SEG methods for some adjustment age segments of the GGB method, the values of ${}_{45}q_{15}$ are for some age segments higher, lower or nearly the same as the values of ${}_{45}q_{15}$ for the SEG or GGB method. These depend on the choice of age segments including a large proportion of peak migration and the central region in question.

This dissertation contains nine Chapters, whereby the second Chapter addresses antecedents of Suriname with respect to Socio-Economic and Demographic characteristics, general view of demographic dynamics, and the civil register system in the country. In the third Chapter, information regarding the data of death and population is provided beside the presentation of the methodology for the evaluation of the quality of the population and mortality data. Additionally, the methodology of the Death Distribution Methods is presented in Chapter three.

In Chapters four, five, six, seven and eight the results of this dissertation are stated. Specifically, Chapter four presents the results of the evaluation of the quality of the death and population data for Suriname and its central regions by sex for 2004-2012. In Chapter five is given the parameters of the DDM methods and their diagnostic plots for Suriname and its central regions by sex for 2004- 2012. Furthermore, Chapter six presents the probabilities of death ${}_{45}q_{15}$ by methods and sex for Suriname 2004-2012. In chapter seven the probabilities of dying ${}_{45}q_{15}$ for the main regions of Suriname for 2004-2012 is shown. Finally, the conclusion of this dissertation is given in chapter eighth, and the adopted Bibliography is presented in chapter nine.

2. ANTECEDENTS: SOCIO-ECONOMIC DIFFERENCES BY REGION IN SURINAME, DEMOGRAPHIC DYNAMICS IN SURINAME, MORTALITY IN SURINAME BASED ON CENSUSES 1950, 1964, 1972, 1980, 2004 AND 2012, DEATH REGISTER IN SURINAME

In this chapter socio-economic and demographic characteristics of Suriname and its main regions are presented. Also, a general view of the demographic dynamics in Suriname is given through the graphical presentation of the age-sex composition of the population in Census 2004 and 2012. Furthermore, some demographic indicators related to the age-sex structure in the last two Censuses held (2004 and 2012) are presented. In the second part of the chapter an overview of mortality and fertility transition and migration, information is given. In the third part, a brief discussion of the functioning of the civil registration system in Suriname and its central regions with respect to the register of death is pointed. The last part presents some final remarks.

2.1 Socio-Economic differences and demographic characteristics in Suriname and its main regions

Suriname is geographically part of South-America and culturally part of the Caribbean. MAP 2.1 presents the geographical features of the country. Suriname is divided into ten districts, and these ten districts are clustered in three central regions namely the urban coastal area, rural coastal area, and the rural interior area. The districts Paramaribo and Wanica belong to the urban coastal area. Districts Marowijne, Brokopondo, and Sipaliwine are part of the rural interior area. The rural coastal area consists of the districts Nickerie, Coronie, Saramacca, Para, and Commewijne. Furthermore, the districts in Suriname are divided in resorts and within the resorts, the division is done through neighborhoods and villages. The numbers of resorts are for the urban coastal area, rural coastal area and rural interior area ***19***, ***25*** and ***18,*** respectively.

MAP 2. 1: MAP of Suriname

Source: http://suriname.startsuper.nl/14455-landkaart-suriname.html

http://members.casema.nl/h.schot/beeldenweb/surkaart780.gif (accessed February 2015)

TABLE 2.1 presents the area of the ten districts of Suriname and also the volume of the population and its population density in Census 2004 and Census 2012. As can be observe district Sipaliwini has the biggest area (130567 km^2) and the capital district Paramaribo has the lowest one **(**182 km^2). According to the data of GBS, district Sipaliwini has the smallest population density[13], 0.3 $habitants/km^2$ followed by district Coronie with 0.8 $habitants/km^2$ and district Brokopondo with 2.0 $habitants/km^2$ in Census 2012.

TABLE 2. 1: Area Suriname by districts, total population and population density Censuses 2004 and 2012 of Suriname

DISTRICTS	AREA	CENSUS 2004	CENSUS 2012	POPULATION DENSITY CENSUS 2004	POPULATION DENSITY CENSUS 2012
Paramaribo	182	242946	240924	1334.87	1323.76
Wanica	443	85986	118222	194.10	266.87
Nickerie	5353	36639	34233	6.84	6.40
Coronie	3902	2887	3391	0.74	0.87
Saramacca	3636	15980	17480	4.39	4.81
Commewijne	2353	24649	31420	10.48	13.35
Marowijne	4627	16642	18294	3.60	3.95
Para	5393	18759	24700	3.48	4.58
Brokopondo	7364	14215	15909	1.93	2.1
Sipaliwini	130567	34136	37065	0.26	0.28
TOTAL	**163820**	**492839**	**541638**		

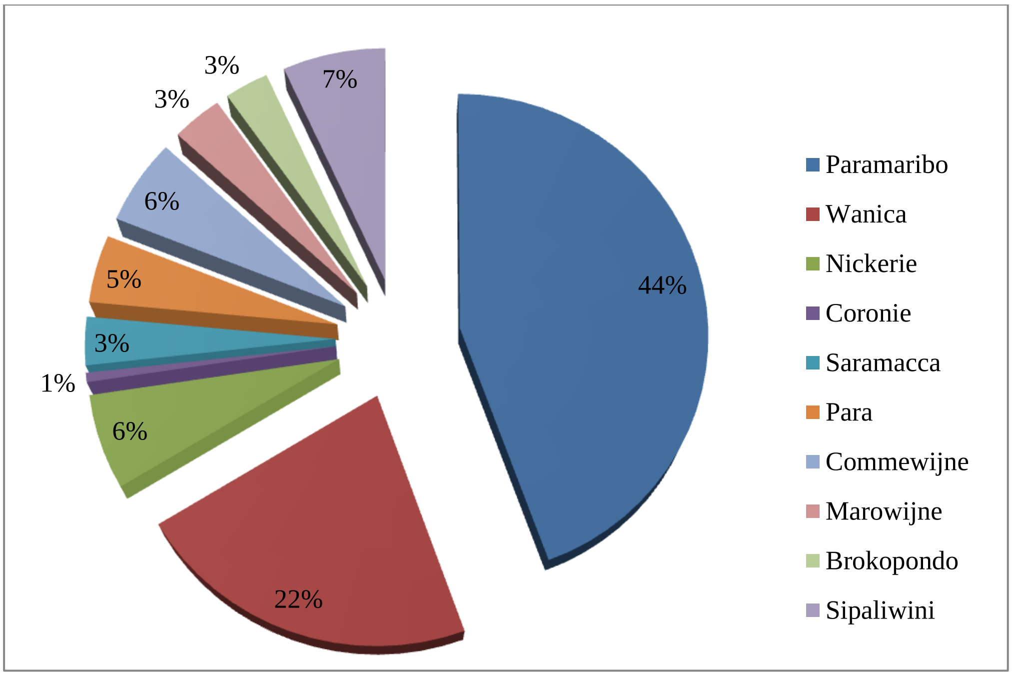
Source: GBS, 2004 and 2012

In FIGURE 2.1 the population of Suriname in census 2012 is presented in percentages by districts. The capital district Paramaribo has the highest percentage (44%) of the population and district Coronie has the smallest percentage (1%) of the population in Suriname. The institutional de jure population and particular groups[14] were in Suriname in Census 2012 about 1.24 % of the total population, whereby 69.97 % were men and 30.03% (GBS, 2013).

[13] Population density is the number of inhabitants divided by the area they populate

[14] **De jure institutional population** is the population who were at the moment of the Census in hospitals, prisons, Child shelters, and shelters for the elderly and other institutions (GBS, 2013). **Special groups** are dwellers, diplomats, persons in hotels and persons on ships in the. (GBS, 2013)

FIGURE 2. 1: Census population of Suriname by district in 2012



Source: Data GBS, 2012

The primary economic activity in Suriname is mining and in minor terms agriculture. The minerals Gold, Oil, and Alumina, cover 95% of the export of Suriname (WORLDBANK, 2011). According to an IMF report, the estimation is that Suriname has grown by 4 percent in 2012, buoyed by the oil and gold sectors, as well as public investment[15].

According to the World Bank Suriname is considered to be an upper middle-income country (2011)[16]. FIGURE 2.2 presents the Gross Domestic Product (GDP) of Suriname in the period 2006-2014. The GDP of 1.79 billion USD in 2006 increased up to 5.23 billion USD in 2014.

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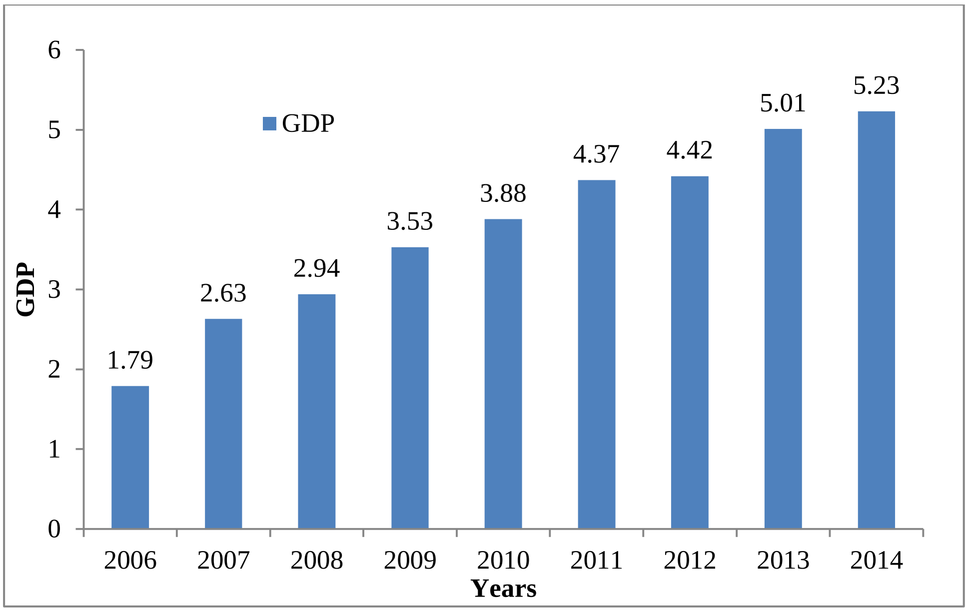
[15] http://www.imf.org/external/pubs/ft/survey/so/2013/car011013a.htm (accessed on 23 of September 2015)

[16] http://chartsbin.com/vieuw/2438 (accessed 22 of September 2015); Upper middle income countries are according to the classification of the World Bank countries with a per capita income in USD in the range 3976-12275

FIGURE 2. 2: GDP of Suriname in Billion USD, 2006-2014



Source: Data Worldbank

According to GBS (2013), the activities of the bauxite sector in Suriname existed for the production of bauxite, alum earth and aluminum until 2000. The stop of the manufacture of alum earth took place in 2000 because of: ***1)*** the lack of enough energy, ***2*)** the old process of the aluminum smelter, ***3)*** high production cost of aluminum, and ***4)*** the decline in the demand for aluminum on the world market. In 2008, the BHP Billiton Suriname took the decision to leave Suriname until 2012. Significant parts of the operation of Billiton were already stopped in 2009. The reasons for the departure of the multinational BHP was that the reserves in the existing concession areas were terminated, and there was not achieved a concordance with the state for new exploitation areas. At the end of November 2015, ALCOA also left Suriname.

Based on the above-stated development of the bauxite sector in Suriname, some labor places were lost and thus affected the household income and consequently the overall welfare of those families and the country. As we can observe, Suriname needs to diversify more its economy to guarantee state revenue for mainly good health, education, and other policies.

On the one hand, in Suriname the labor force participation rate for the age group, 15-64 increased from Census 2004 to Census 2012 for the male, female and total population. On the other hand, the unemployment rate decreased from Census 2004 to Census 2012 for the male, female and total population in Suriname. TABLE 2.2 presents the results calculated based on data of GBS. The unemployment rate in the total population was in census 2004 and 2012, ***8.77*** and ***7.88***, respectively and it decreased between both censuses.

TABLE 2. 2: Economic status population 15-64 in Suriname Census 2004 and Census 2012

Sex	CENSUS 2004		CENSUS 2012	
	Employed	**Unemployed**	**Employed**	**Unemployed**
Male	65.82	7.81	68.50	6.11
Female	35.52	9.66	39.42	9.63
Total	***50.69***	***8.77***	***53.84***	***7.88***

Source: Census data 2004 and 2012, GBS

The social and economic development is diverse in the different districts of Suriname. The districts Paramaribo, the capital of Suriname, and district Wanica, which belong to the urban coastal area, has 66 % of the whole population living there. A significant part of the population of Wanica works in the capital. Paramaribo is the most important economic and trade center of the country and in district Wanica, the economic activity is horticulture and cattle breeding[17].

In district Brokopondo, there is the only hydroelectric installation of the country, besides the National Nature Park. The economic activities are gold mining and forestry. A great part of the Marroon population lives in district Brokopondo. District Sipaliwini is for 90% composed of rainforest, and the Central Suriname National Reservation is part of it. The population of district Sipaliwini is composed by Indigenous and part of the Marroon population. In district Marowijne, the economic activities are Fishery, Mining, Trade with French Guyana, deforestation, and tourism[18].

District Commewijne is characterized by the successful history of the plantations, and the economic activities are tourism, agriculture, cattle breeding, and fishery. The economic activities in district Saramacca are Mining of Petroleum, agriculture, and horticulture. In district Para, the economic activity is tourism. Concerning district Coronie, the economic activity is agriculture, cattle breeding, and fishery. In district Nickerie, the second biggest city of Suriname the economic activity is mainly agriculture, namely the plantation of rice and banana. Aquaculture is also an economic activity in district Nickerie [19]. Besides the small population of Suriname the peculiar thing is that based on history, Suriname is composed of different ethnic groups and thus can be considered a multicultural society. FIGURE A1, in

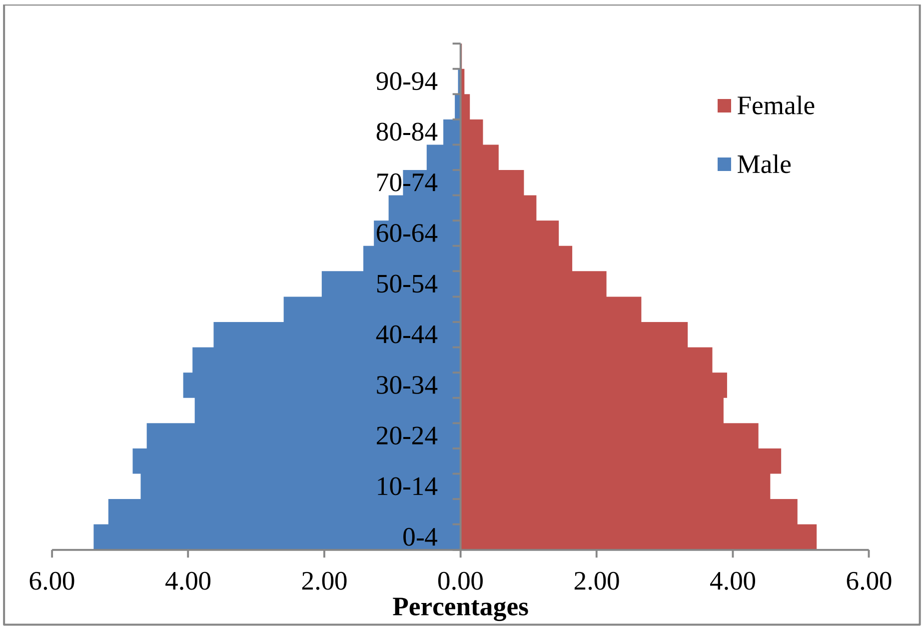
[17] http://www.visitsurinameonline.com/nl/algemeen (accessed 29 September 2015)
[18] http://www.visitsurinameonline.com/nl/algemeen (accessed 29 September 2015)
[19] http://www.Surinamevieuw.com/districten (accessed, 29 of February 2016)

ANNEX A, depicts detail information of the ethnic population composition in the last Census of 2012. The biggest population group in Suriname in Census 2012 is the Indian group (27.41%) followed by the Maroon group (21.71%), the Creole (15.68%) and Javanese (13. 66 %).

2.2 General view of the Demographic dynamics in Suriname

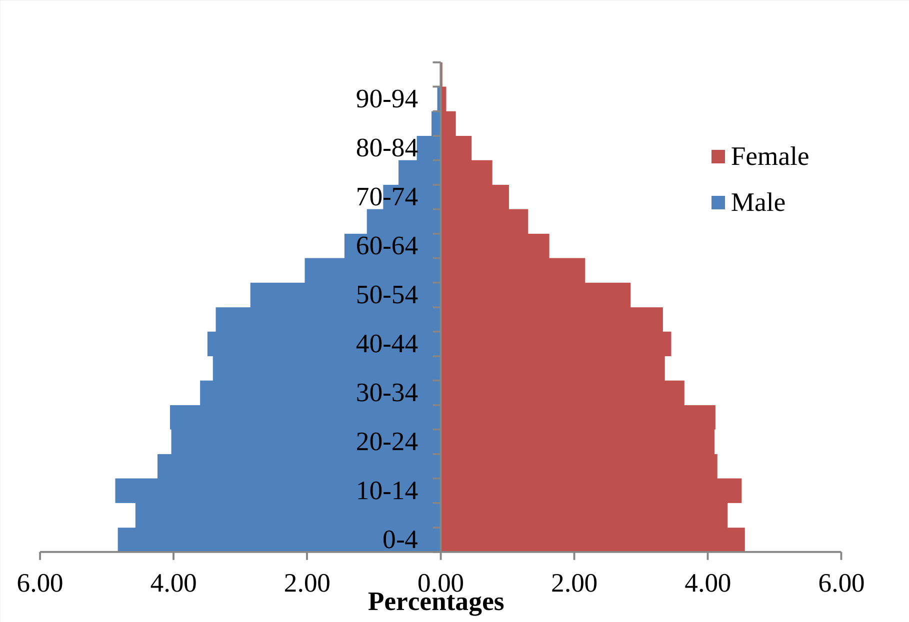
To have a better understanding of this mortality study of Suriname, it is important to present first a percent pyramid of the last two Censuses held in Suriname (2004 and 2012). The percent pyramid shows the differences or changes in the proportional size of each age-sex groups (Shryock and Siegel, 1980). FIGURE 2.3 and FIGURE 2.4 show the population by sex and age composition in Census 2004 and Census 2012, respectively. Census 2012 present in relation to Census 2004 a smaller base and migration effects are also observed in the young adult age groups in both censuses. Furthermore, Pyramid 2012 also reveals the fertility decline in Suriname about Census 2004.

FIGURE 2. 3: Pyramid Census 2004, Suriname



Source: Census data 2004 (GBS)

FIGURE 2. 4: Pyramid of Census 2012, Suriname



Source: Census data 2012 (GBS)

Shryock and Siegel (1980) mention that age is the most significant variable in the study of mortality, fertility, migration and other areas of demographic analysis. Based on the age-sex composition the percentage of the population in each age group the so-called age total dependency ratio[20] can be calculated. The TDR provides the information about the population which is economically dependent concerning those who are in their working age. TABLE 2.2 presents percentages of main age groups for Census 1950, 1964, 1972, 1980, 2004 and 2012.

TABLE 2. 3: Percentages main age groups Censuses held in Suriname 1950-2012

Age groups	Census 1950	Census 1964	Census 1972	Census 1980	Census 2004	Census 2012
0-14	41.2	46.6	48.3	39.7	30.0	27.6
15-59	51.7	47.2	45.7	53.8	61.4	62.2
60+	7.0	6.2	6.1	6.6	8.6	10.1
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Data GBS, Census 1950, 1964, 1972, 1980, 2004 and 2012

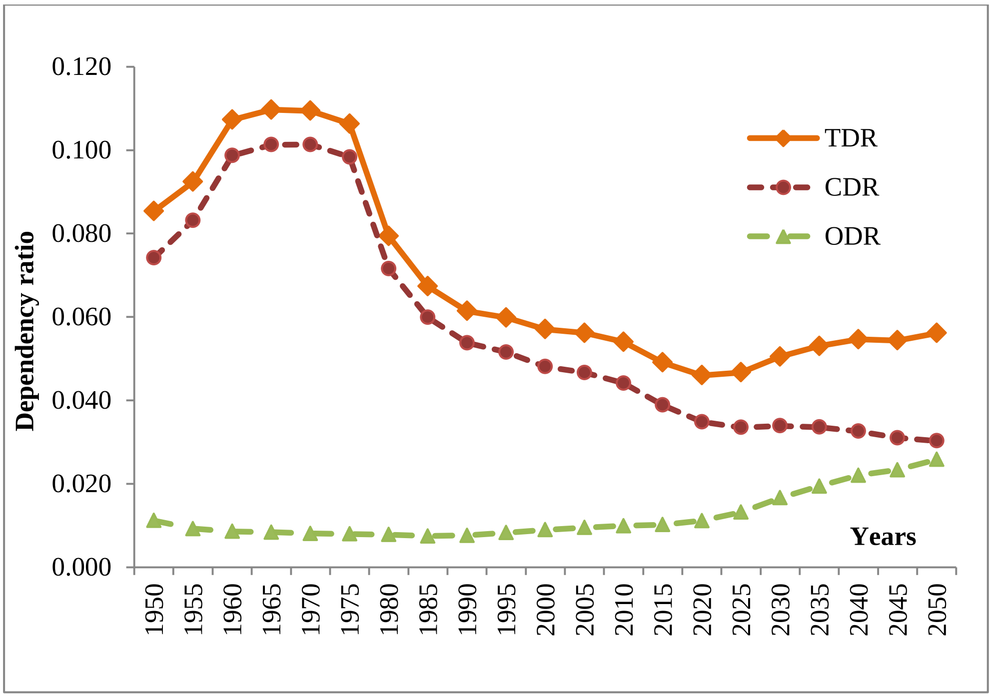
[20] The age dependency ratio is the variation in the proportions of children, aged person and working age population (Shryock and Siegel, 1980). In formula the age dependency ratio or total dependency ration is

$$TDR = \frac{P_{0-14} + P_{65+}}{P_{15-64}} * 100$$

Since 1972 the population of 0-14 is declining, while the population of 15-59 and 60+ is increasing. The decrease in the age group 0-14 from 1950 to 2012 is about 13.6 %. For the age groups 15-59 and 60+ the increase for the same period is 10.5 % and 3.1%, respectively.

In FIGURE 2.5 we observe the development of the child dependency ratio (CDR)[21], old age dependency ratio (ODR)[22] and the total dependency ratio from 1950-2050 of Suriname, based on data of the United Nations. It is a clear that the TDR is declining after 1975 up to 2020 and then increase again as a consequence of the rise of the ODR after 2015. However, the CDR is declining after 1975 up to 2050.

FIGURE 2. 5: Total dependency ratio, Child dependency ratio and Old age dependency ratio of Suriname 1950-2050



Source: World Population Prospects 2012 (UN)

or $TDR = \frac{P_{0-14} + P_{60+}}{P_{15-59}} * 100$

21 $CDR = \frac{P_{0-14}}{P_{15-59}}$ or $CDR = \frac{P_{0-14}}{P_{15-64}}$

22 $ODR = \frac{P_{60+}}{P_{15-59}}$ or $ODR = \frac{P_{65+}}{P_{15-64}}$

In Suriname, the decline of mortality and fertility started between 1965 and 1970. The effects of international migration in the period 1973-1980 are also notable in the small distance between the TDR and the CDR. Furthermore, the decline in TDR and CDR is very steady after 1975, due to international migration. With this discussion, we observe that Suriname is still in the middle process of the first demographic transition. The demographic transition involves the fertility and the epidemiological transition (Thompson, 1929; Notestein, 1954). The fertility transition implies the change of high fertilities to lower ones. The epidemiological transition refers to the decline of acute infectious disease and the increase in the degenerative disease (Omran, 1971). As can be observed Suriname is date 2016 in the third phase of the demographic transition, namely the demographic dividend[23] and simultaneously in the beginning stage of the aging process. In Census 2012 the share of the working-age population was 62.2 % in Suriname.

In TABLE 2.4 the child, old age and total dependency ratios for the central regions of Suriname for Census 2004 and Census 2012 are presented. As can be seen, the child dependency ratio for the rural interior area is near twice the one of the urban coastal area in 2004 and 2012, respectively. The old age dependency ratio between the three regions does not differ a lot in both censuses.

TABLE 2. 4: Dependency ratios main regions Suriname Census 2004-2012

	URBAN COASTAL	**RURAL COASTAL**	**RURAL INTERIOR**	**SURINAME**
DEPENDENCY RATIOS		**CENSUS**	**2004**	
CDR	0.4423	0.4778	0.8076	0.4896
ODR	0.1389	0.1436	0.1484	0.1409
TDR	0.5812	0.6214	0.9561	0.6306
DEPENDENCY RATIOS		**CENSUS**	**2012**	
CDR	0.3949	0.4200	0.8078	0.4443
ODR	0.1655	0.1505	0.1693	0.1628
TDR	0.5604	0.5705	0.9771	0.6071

Source: Data based on Census data 2004 and 2012, GBS

On the total dependency ratio, we notice that the rural interior area has the highest one within the three regions in both censuses. This high result of the overall dependency ratio in the rural interior area is due to the high child dependency ratio in this small populated area. So, the

[23] The demographic dividend is the increase of the working age population (Mason, 2005)

working age population in the rural interior area is of a smaller proportion compared to this population in the urban coastal and rural coastal area.

2.2.1 Mortality overview

The analysis of the death statistics from Centraal Bureau Burgerzaken - CBB of Suriname depends on the demographic data from the census or yearly population estimation. The results of CBB may suffer from incomplete registration of birth and death mostly in the period of the sixties, seventies, and eighties. Possible explanation is that the geographical location of the rural population concerning support offices of CBB was in that time not nearby, and thus, they had not the possibility of these communities to register birth and death on time. In the past, there were also less registration support offices of CBB in the country and the central regions of Suriname in comparison with nowadays. Moreover, FIGURE A3 in ANNEX A presents the absolute number of deaths and births in Suriname from 1924-2013.

Important information in this mortality study is on the leading causes of death because a better understanding of mortality in Suriname takes place. For Suriname the main 50 causes of death published by World Health Rankings in 2011 reveal that number one was the stroke (21.08%) followed by coronary heart disease (13,01%) and HIVAIDS (6,38%). Data of Bureau Openbare Gezondheidsdienst (BOG) for the period 2004-2011 (ANNEX A, TABLE A1) show that the mean percentage of the three leading causes of death in Suriname was the cardiovascular and Cero vascular disease (27.94%), followed by Accidents and Violence (12.05%) and Maligne Neoplasms (11.36).

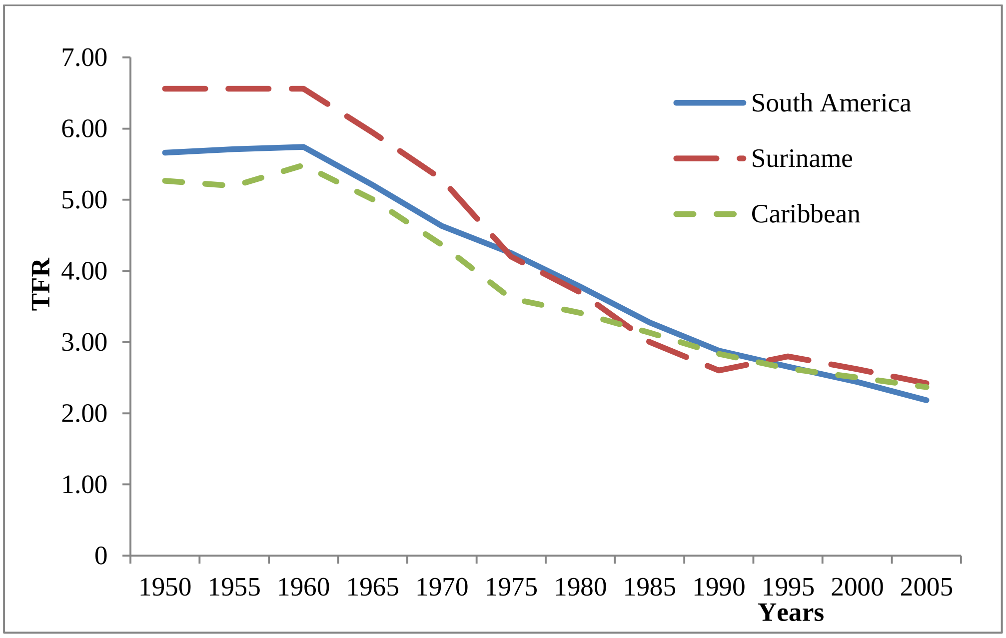
On external causes of deaths in 2011, the information of BOG is that 33.9 % of the external causes of deaths were suicide, and 23.7% of the apparent category deaths were traffic accidents on land. Based on the data of BOG mortality in the urban coastal area was due to cardiovascular diseases in 2008, 2009, 2010 and 2011 respectively, 63.49%, 61.84%, 62.99 %, and 62.84 %. FIGURE A4 in ANNEX A depicts the results for the five ethnic groups with the highest percentage of the cause of death due to cardiovascular diseases in Suriname for the period 2008-2011. As can be seen the greatest group of mortality as a result of cardiovascular disease are the Indian population followed by the Creole and the Javanese.

2.2.2 Fertility Transition

Concerning the demographic component fertility, we can observe that according to the data of the United Nations (World Population Prospects, 2012) even as in other developing countries in South America and the Caribbean the trend of decline in fertility is also notable in

Suriname. FIGURE 2.6 show that the Total Fertility Rate (TFR) of Suriname was from 1950-1975 above the TFR of South America and the Caribbean. From 1975 – 1990 the TFR of Suriname was below of the values of South-America or the Caribbean. For the period 1990-2010, the TFR of Suriname is higher than for the regions. The result of lower TFR for the period 1975-1990 is an effect of the vast exodus of Surinamese's of 123.780 persons to the Netherlands from 1973-1980, due to the independence in 1975. The midyear population of Suriname in 1975 was approximately 364.499 and the population at the end of the year was 350.309 (CCB, 2002). In 1975, the emigration to the Netherlands was of 39.699 habitants which are 32.07 % of the emigration for the period 1973 - 1980 (CBB, 2002).

FIGURE 2. 6: Total Fertility rates of Suriname, South America, and the Caribbean 1950-2010



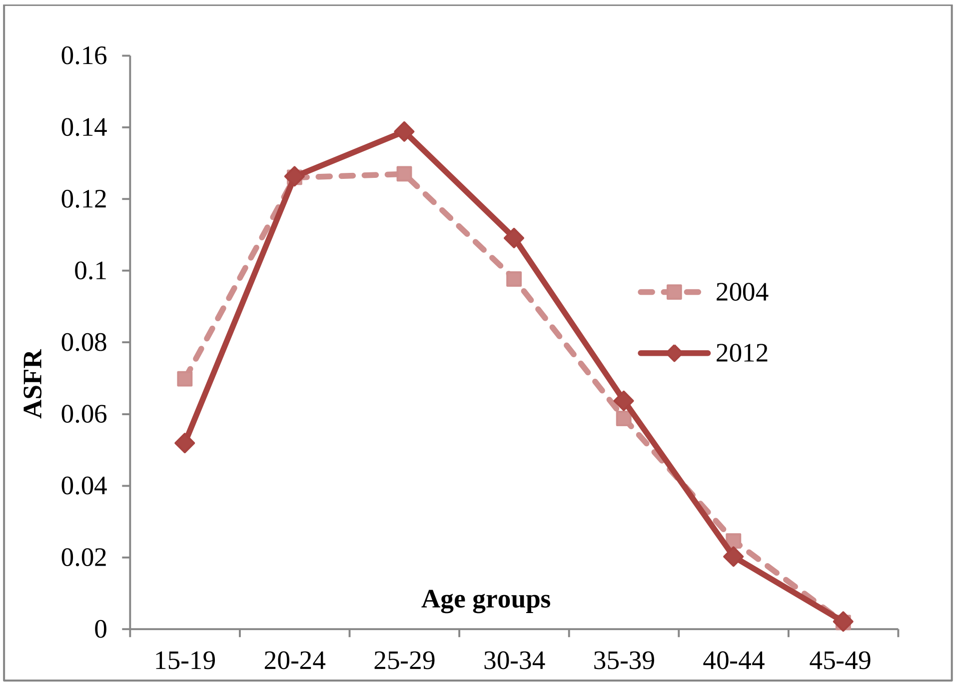
Source: World Population Prospects 2012, UN

In Suriname, for the lifetime fertility, we can observe some differences in the various ethnic groups. According to GBS (2012), the Maroons presents the highest total fertility rate in Census 2004 and 2012, respectively ***2.8*** and ***2.9.*** The total fertility rate is the number of children a woman may have if she survives at the end of her reproductive period (Preston *et al.*, 2001).

The Javanese population and other groups had a total fertility rate of respectively ***2.0*** in Census 2004 and 2012. For Census 2004 and 2012, the total fertility rate of the Indian population was respectively, ***1.9***. TABLE A2 and TABLE A3 in ANNEX A present the age-specific rates and the total fertility of the population by ethnic groups respectively, in census 2004 and 2012.

FIGURE 2.7 shows the age-specific fertility rates (ASFR) for census 2004 and 2012. ASFR is the number of births in a particular period divided by the person-years lived off the population in question during the same period (Preston *et al.*, 2001).

FIGURE 2. 7: Period age-specific fertility rates in Suriname Census 2004-2012



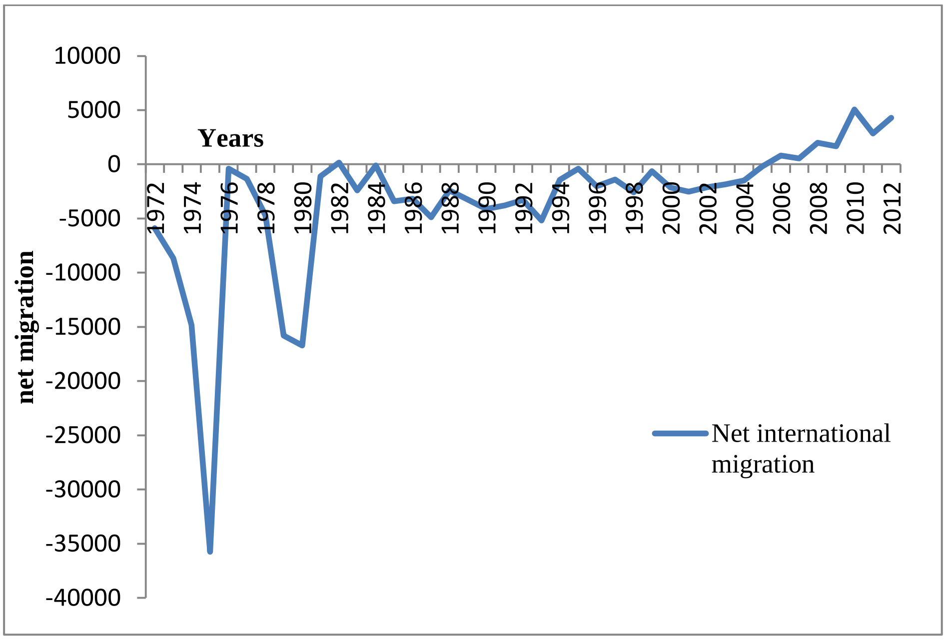
Source: Census data 2004 and 2012, GBS

In Census 2012, ASFR is higher for the age groups 25-29, 30-34 regarding Census 2004. In Census 2012 adolescent ASFR declined *0.0179* in relation to census 2004. For age group 20-24 ASFR is nearly the same in both Censuses. The total fertility rate (TFR) in Census 2004 and 2012 are respectively, ***2.53*** and ***2.56*** **(**GBS, 2012**).**

2.2.3 Migration

On migration, we observe that international and internal migration occurs in Suriname. FIGURE 2.8 presents the international net migration history of Suriname from the period 1972-2013. As can be seen, the peak period of negative net international migration was from 1973-1975 and 1980. Crucial years were the year of the independence in 1975 and the year in which a military coup took place in 1980. After 2005, the net international migration in Suriname is active probably due to public policy “Clean Sweep” of the Surinamese government to incentive illegal pork knockers and garimperios and others strangers to become legal (registration as immigrant). The operation ***"Clean Sweep"*** started in July 2008 and had the intention to organize the small-scale gold mining in the hinterland of Suriname (Fernand, A. I., 2009). Currently, the Surinamese government makes efforts to organize the small-scale gold mining.

FIGURE 2. 8: International net migration in Suriname 1972-2012



Source: Data CBB, 1972-2012

Furthermore, FIGURE A5 in ANNEX A present the effects of international migration on the population growth rate of the Surinamese population compared to Southern American and the Caribbean countries. The impact of international migration in FIGURE 2.9 observed is also reflected in FIGURE A5, ANNEX A. The growth rate of the Surinamese population was for the period 1970-1975 negative ***(-0.429),*** based on data from UN.

As the FIGURES B6 and B7 in ANNEX B show the age structure of internal migration of the male and female population of the country is not the same for the period 2004 - 2012. The male population has its maximum value in the ages 0 - 4 and is a declining up to 15 - 19 to reach a maximum again in the age 20 - 24, which is a lower peak than the one in age 0-4. For a female population, the age structure of migration presents a steadier increase after age 10 - 14 to reach its peak at age 20 - 24, a higher one than for age 0 - 4. After age group 20 - 24 the proportion of female migrants decline. Common for the male and female population is that age 20-24 presents peak migration. However, the percentage of female population in age groups 20-24 is on average higher than for male population in the period 2004-2012. The explanation of the differences in migration pattern between male and female population can only be given after a qualitative research.

According to data of GBS (2011) the internal migrants move more from the rural interior area to the urban coastal area, from the rural coastal area to the urban coastal area and from the rural interior to the rural coastal area. The internal migration in 2012 from rural interior area to urban coastal area and from rural coastal area to urban coastal area was 78.04 % and 77.49 % of the internal migrants, respectively.

The yearly movement of people from the urban coastal to the rural interior area is on average smaller than to the rural coastal area. In 2012, the movement of people from urban coastal to rural coastal and to the rural interior was 29.20 % and 12%, respectively. The movement within the urban coastal area was in 2012 nearby 58.80 %. In FIGURE A 6 in ANNEX A, the net internal migration in Suriname by districts for the period 2004 -2012 is depicted. TABLE 2.5 presents the mutual migration flows in absolute numbers of urban coastal, rural coastal and rural interior districts for the period 2004-2009.

TABLE 2.5 reveals that the flows from urban coastal to rural coastal and rural coastal to urban coastal present yearly values close to each other. Remarkable is that the flow from the rural interior area with the smallest population to the urban coastal area with the biggest population may cause a larger effect on the population change of the rural interior area. The fact that great part of the male and female population moves in the age groups of labor productivity the effects of migration will be more notable in the results of adult mortality in the small populated rural interior area. Moreover, move from urban coastal to the rural interior area is yearly on average four times the move from rural coastal to the rural interior area. The greater preference to move from the urban coastal to the rural interior area may be explained by the presence of mining activities in the rural interior area.

TABLE 2. 5: Mutual migration flow (absolute numbers) main regions Suriname, 2004-2009

	Year	TO								
		Urban Coastal			Rural Coastal			Rural Interior		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
FROM	Urban Coastal	-	-	-	1907	2195	1597	726	959	810
	Rural Coastal	1932	1985	1900	-	-	-	164	192	160
	Rural Interior	1317	1585	1360	225	312	155	-	-	-
	Year	TO								
		Urban Coastal			Rural Coastal			Rural Interior		
		2007	2008	2009	2007	2008	2009	2007	2008	2009
FROM	Urban Coastal	-	-	-	1825	2002	1909	964	882	783
	Rural Coastal	2219	2090	1805	-	-	-	194	170	216
	Rural Interior	1498	1489	1195	243	337	211	-	-	-

Source: GBS, 2011

2.3 System of civil register of mortality in Suriname and its main regions

BOG, a department of the Ministry of Health and the Centraal Bureau voor Burgerzaken (CBB) of the Ministry of Internal Affairs are involved in the collection of death count data. However, the registration of mortality of citizens is done at CBB. According to a colonial law of June 5 of 1944 all the babies who born and died before the registration of birth are not registered as death (Surinaams Burgelijk Wetboek, Boek 1, and article 43)[24]. In the Nieuw Burgelijk Wetboek, Boek 1, Article 19i; 2 the registration of birth and death is done if the child dies within the period of legal registration of birth (five days) mention in article 19e; 6. Further, the law states that the register of death should happen within 24 hours after the death in the capital Paramaribo and seven days after death in the other districts (Nieuw Burgelijk Wetboek, Boek 1, article 19h; 4, 2011)[25]. The registration of death could be done personal or by written through a family member or other person of the one who died[26]. In case, the register is not done within the period determinate by the law the civil servant of the Central

[24] http://www.dna.sr/media/19726/burgelijk_wetboek.pdf (accessed on 07 February 2015)
[25] http://www.gov.sr/sr/ministerie-van-juspol/documenten (accessed on 07 February 2015)
[26] Nieuw Burgelijk Wetboek, Boek 1, article 19h1, 2011; Surinaams Burgerlijk Wetboek, Boek 1 article 43

Bureau of Citizen Issues (CBB) of the Ministry of Internal Affairs has to inform the Public Prosecution Service (Openbaar Ministerie - OM)[27].

Moreover, in Suriname, the registration of death according to the Department of Citizen Issues (CBB) of the Ministry of Internal Affairs involves four forms (A, B, C and D). The form C, Death Certificate is acquired from CBB or the hospitals[28]. The hospitals hand out Death certificates of those who died in the hospital. However, when the family doctor confirms the death of the patient the C form is acquired from CBB. According to BOG the medical doctor who confirms death is by law obligated to fill in the C-form. In return, the medical doctor sends the C- form in a closed envelope (B-form) with form A with personal information of the one who died to CBB. After the registration of death by the family, CBB sends the envelope with the Death certificate and the form D (living district and folio number) to the Department of Epidemiology/Biostatistics of BOG. The information of the A and D form need to be identical. There are cases in which the age of death is registered as unknown. Furthermore, BOG mentions that the causes of death on the Death Certificate are since 1995 based on the International Classification of Disease and related health problems, the tenth revision.

Every family needs to acquire a family book which is an administrative document offered by a civil servant of Central Bureau for Citizen Issues of the Ministry of Internal Affairs. In the family book, the demographic events such as birth, death and migration of a family and other events are registered[29] (according to Surinaams Burgelijk Wetboek (S.B.W. article 5). The family book represents the personal information with different records of CBB from parents and children. The family book is necessary to make the health care card from Staatszieken Fonds (S.Z.F.)[30], for the ministry of social affairs in case of necessity for social assistance, or acquirement of old age pension (Algemene Oudedags Voorziening - AOV). Additionally, the family book can be used to apply for childcare benefit, to inscribe children at school, and for other institutions or occasions. Eligible for the acquirement of the family book are ***1)*** Married

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[27] Nieuw Burgelijk Wetboek, Boek 1, article 19e; 6, 2011 (accessed on 03 April 2015)
[28] www.surinamebusinessforum.org/smartcms/downloads/pdf/Statistiek_Seminar2(6aug).pdf (accessed 18 of July 2015)
[29] http://www.gov.sr/media/779665/cbb_serie.pdf; Page 1 (accessed on 03 of April 2015).
[30] Staatszieken Fonds is the fund of the Government for the sick person

men and women, ***2)*** divorced men and women, ***3)*** Not married women with children, ***4)*** not married men with recognized children[31], and ***5)*** Widows.

The Department of Citizenship Issues (Centraal Bureau voor Burger Zaken - CBB) of the Ministry of Internal Affairs has 47 bureaus in the country, and every district has, at least, one registration bureau, from which 41 offices (87.23%) conduct birth and death registration. In the urban coastal area where 66.31% of the total population (541.638) lives there are 12 bureaus of CBB for birth and death registration, while in the rural coastal area (where 20.53% of the total population lives) there are 17 bureaus registering birth and death. Furthermore, in the rural interior area (where 13.16% of the total population lives), there are ten bureaus performing birth and death registration.

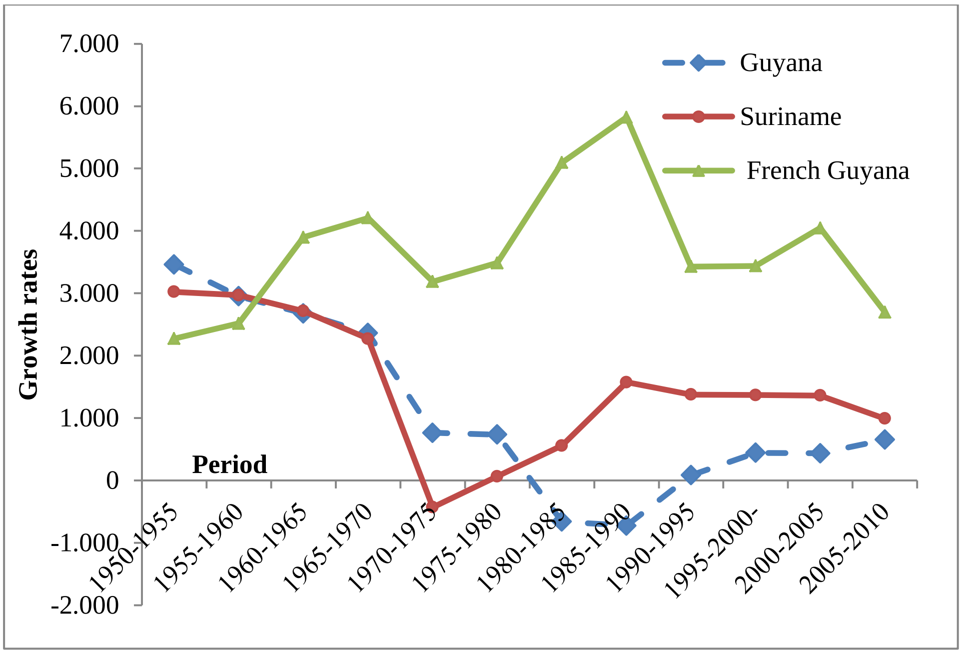
2.4 Final Remarks

The population composition and migration characteristics of Suriname are more similar to the neighbor country Guyana. Considering the size of the population, Suriname is related to Guyana and French Guyana. Suriname is the after French Guyana the second country in South-America with the smallest population. The population of French Guyana had on the first of January 2012, a population of 239.450 habitants[32]. The volume of the total population of Suriname is also close to the total population of other Caribbean countries (Islands). FIGURE 2.9 presents the growth rates of Suriname, Guyana and French Guyana for the period 1950 - 2010. On the growth rates, Suriname is more similar to Guyana, due to their common migration characteristics.

[31] In the Surinaams Burgelijk Wetboek (SWB) a recognized child is a natural child that is accepted as the man his child.

[32] http://www.bdm.insee.fr (accessed on 11 of January 2016)

FIGURE 2. 9: Growth rates of Suriname, Guyana, and French Guyana 1950-2012



Source: Data UN, World Population Prospects, 2012

However, although the official language of Suriname is Dutch, different other languages are spoken in Surinamese households. In Census 2004 the first most spoken language within the households is Dutch (46.6%) and the second language that is spoken (37%) is ***"Sranang Tongo"*** (37%**).** The ***"Sranang Tongo"*** language is a Creole language whose development began in the 17 *th* century with the importation of slaves from West Africa[33]. According to GBS, the third most spoken language declared in Census 2004 in Suriname was the "***Sarnami"*** language (15.8%), a dialect of Hindi (Indian) language[34].

Considering the religion characteristics of Suriname in Census 2004 the three main religions in Suriname were Christians, Hindu, and Muslim, with the percentages of 40.76%, 19.95%, and 13.46%, respectively. The multi-ethnic society of Suriname might result based on the different cultural backgrounds in different fertility and mortality outcomes.

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[33] http://www-01.sil.org/americas/Suriname/Sranan/STEng.pdf. (accessed on 30 December 2015)
[34] http://www.hermanboel.eu/language-database/lg_sarnami-hindi.htm (accessed on 30 December 2015)

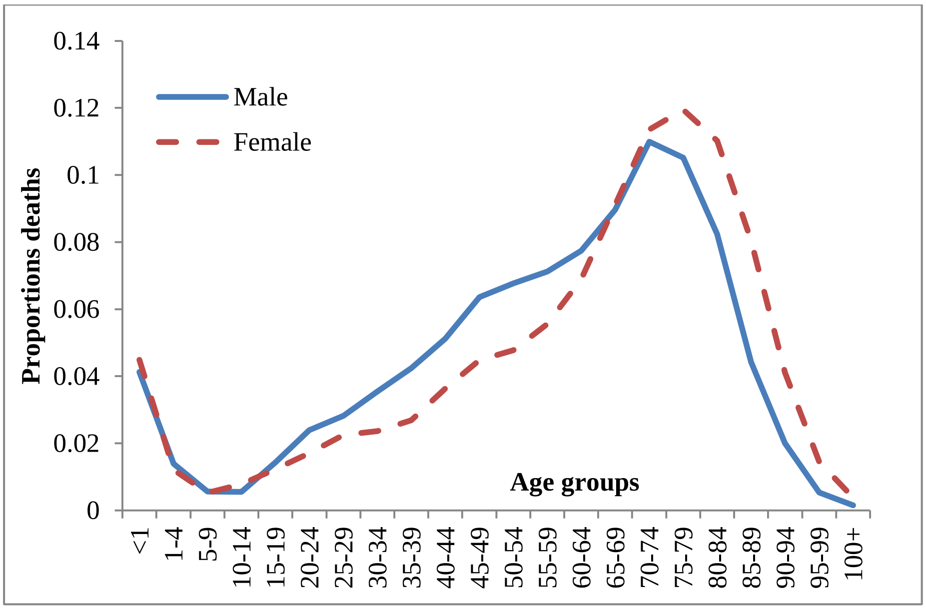
3. DATA AND METHODS

In the first part of this chapter, the origin and characteristics of the death counts, population, and migration data is presented. The second part points out the indicators to evaluate the data quality of the population and the death counts. Additionally, the Death Distributions Methods are adopted to estimate the probability of dying ${}_{45}q_{15}$ are also presented in the second part.

3.1 Data

The Ministry of Health, Department of public health (BOG) and the Ministry of Internal Affairs, Department of Central Bureau for Citizenship Issues (CBB) perform the collection of death count in Suriname and its main regions as see before. However, the death count for the purpose of this dissertation was obtained from the CBB, since the registration of demographic events is one of their legal obligations[35]. CBB yearly publishes data on birth, death, marriage, divorce, recognized children and internal and external migration of the year (s) before. For the purpose of this dissertation, death counts from 2004-2012 of CBB are used. FIGURE 3.1 presents the proportion of the death average counts for Suriname from 2004-2012 within the group of male and female population.

FIGURE 3. 1: Proportion of average death counts, male and female population in Suriname, 2004-2012



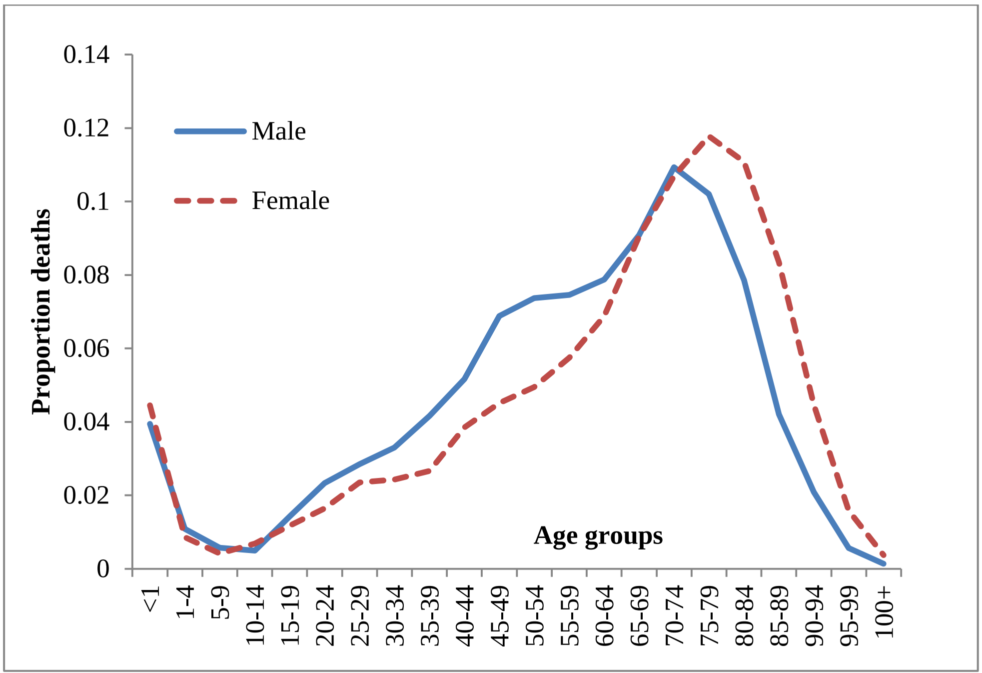
Source: Data of CBB, 2004-2012

[35] http://www.gov.sr/ministerie-van-biza/diensten/cbb.aspx (Accessed 27 of July 2015)

As can be observe, for Suriname the proportion of male death counts is more than for female population between the age groups 15-19 up to 60-64. A possible explanation that can be given is that male suffers in relation to female population more from external causes of deaths death due to, cardio vascular diseases and deaths related to jobs with high risks of accidents. In 2010 and 2011 of those male who died due to cardiovascular disease the percentage was 24.13% and 25.03% respectively and for the age groups 15-19 up to 60 - 64 (BOG, 2012). For external causes of deaths, the figure was much higher. Out of the total number of external causes of deaths 56.95% and 63.90 % were male population of the age group 15 - 19 up to 60-64, for the years 2010 and 2011 respectively. In the age group 50-54 there is an overall peak of the proportion of male deaths (0.074).

For the age groups 65 - 69 up to 75 - 79 proportions of male and female deaths are nearly the same. Probably emigration of female population and/or immigration of male population at elder ages may explain this phenomenon. As expected for age groups 70 - 74 up to 100+ the registration of female death within this group is higher than within the male group. For the ages of 10 - 14 and below, the death record within the male and female population is nearly the same.

FIGURE 3. 2: Proportion of average death counts for the urban coastal area, male and female population 2004-2012



Source: Data of CBB, 2004-2012

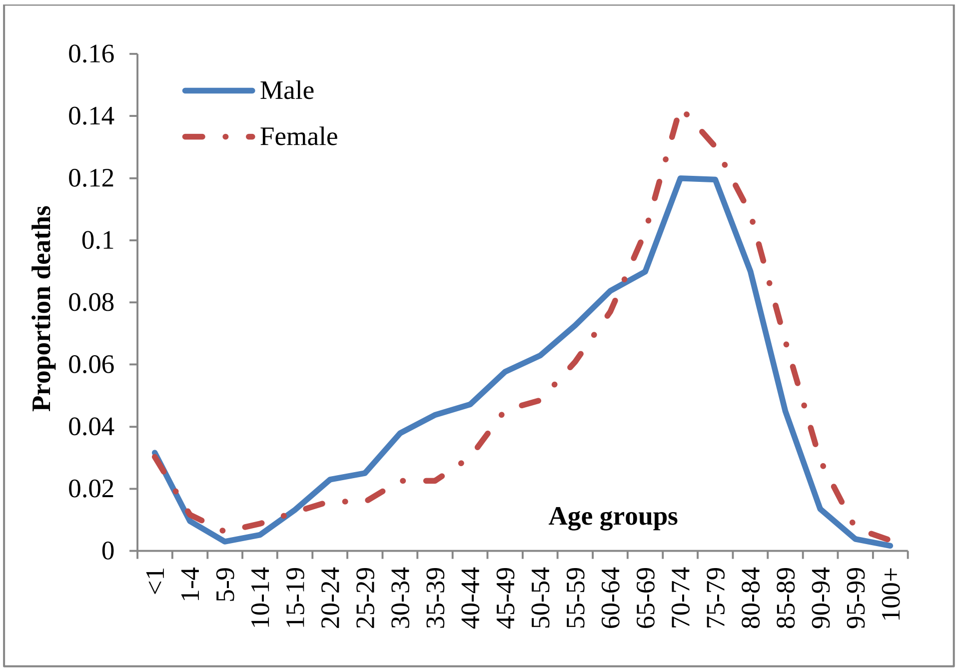
The proportion of death counts for the urban coastal area for male and female population looks like those of Suriname, because socio-economic development of the urban coastal area is close to that of the country. In FIGURE 3.2 the result of the urban coastal area is presented. The remarkable difference between the proportion of death counts between the country and the urban coastal area is that for the age groups less than one year more female death are registered and between 1 - 4 up to 5 - 9 more male death are registered. A probably explanation that can be given for higher registration of female death counts for age less than one year may be the under registration of male death or migration of this group.

However, as expected the proportion of death count for the rural coastal area and rural interior area is different than those of the country and the urban coastal area. The socio-economic development of the rural areas is less than that of the urban coastal area, but better than the rural interior area (HDA, 2013). FIGURE 3.3 and 3.4 present the proportion of male and female death counts for the rural coastal area and rural interior area, respectively.

As can be observed already starting at age 65-69 the death counts for the female population of the rural coastal area are higher than male population up to 100+. A probable justification that can be given is that in the rural coastal area men of specific cohorts do not survive up to the age of 65 and older. For age group 1 - 4 up to 10 - 14, the proportion of death counts for the female population is higher than for male population in the rural coastal area. The more plausible explanation that can be given is due to migration of male population. Between age groups 15 - 19 up 60 - 64 the percentage of death counts for the male population of the rural coastal area is even as for Suriname and the urban coastal area greater than for female population, which can be justify in the same way as is for the country and urban coastal area.

Furthermore, the female population of the rural coastal area shows higher levels of the proportion of death counts for age groups 70 - 74 and 75 - 79 than for the country, urban coastal area, and rural interior area.

FIGURE 3. 3: Proportion of average death counts for rural coastal area, male and female population 2004-2012

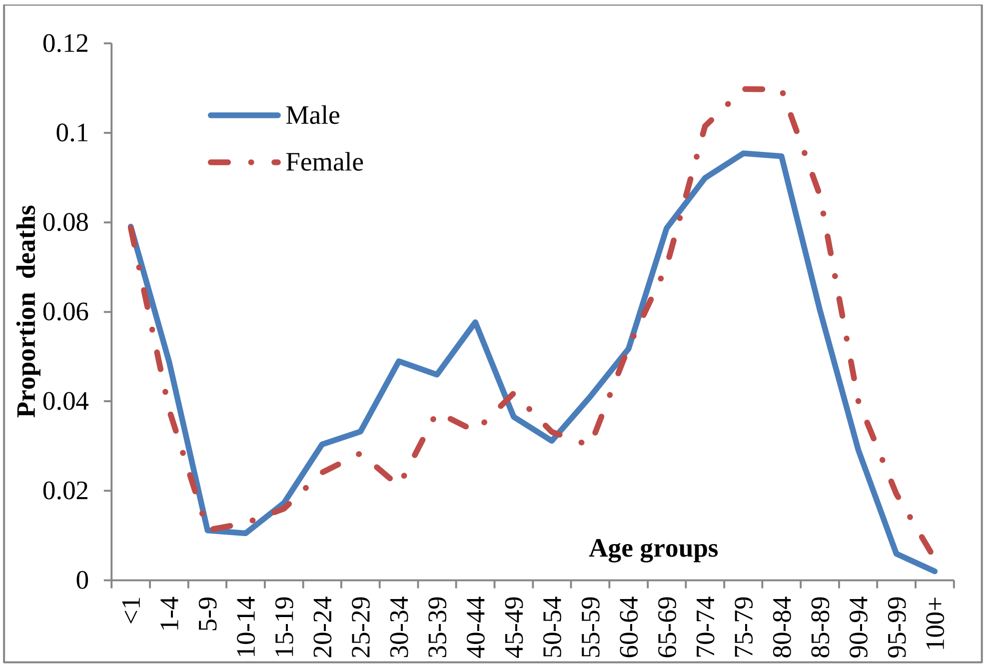


Source: Data of CBB, 2004-2012

Analysing the percentage of death counts for the rural interior area we observe that the proportion of death counts for age group <1 are for male and female population higher (***nearly twice***) than for the country and the two other regions. The possible explanation that can be given is that the percentage of new born of the population of the rural interior area is also high.

For age groups 5 - 19 up to 45 - 49 the death counts for male are greater than the female population in the rural interior area. There are peak values for male in the age group 30 - 34 and 40 - 44 which may be justified by external causes of deaths. For the age group 65-69 in the rural interior area more registration of male population death in relation to women occurred. This may be due to outmigration of the male population. Starting from age group 70 - 74 up to 100+ the proportion of female death count in the rural interior area is higher than for male. However, the distance between male and female death count for age group 85 - 89 up to 100+ is smaller for the rural interior area than for the urban coastal area and for the country.

FIGURE 3. 4: Proportion of average death counts, for rural interior area, male and female population, 2004-2012



Source: Data of CBB, 2004-2012

The data of death registration from 2004 -2012 are inclusive deaths of non-residents. According to CBB (2004-2012), the death registration of the population is conducted per district. Likewise, CBB registers death related to ***"abroad"*** when the death person had a current address in another country but died in Suriname or else was a stranger who had lived illegally in Suriname. For the calculation of the annual death, the demises related to the exterior are added to the deaths of the capital Paramaribo; and thus, considered in the calculation of the deaths in the urban coastal area. In the CBB support office, the death registration is conducted on the local population of the district where the person had lived and not where the death occurred. Part of the death related to ***"abroad"*** are illegal strangers who have lived in Suriname. The other group of strangers had a current address "***abroad***" but was also living in Suriname. In both cases, the death related to ***"abroad"*** is based on the definition of death registration, and thus, these data are included in the calculations. The annual death counts refer to the deaths that occurred from January, 1st to December, 31st of every year. The population data is by sex, single years, and by age groups of five years from Census 2004 and 2012.

3.2 Migration data

The migration data used in this study is also from CBB, which yearly produces these data. This department of the Ministry of Internal Affairs conducts the registration of internal migration within districts, from district to district and international emigration and immigration. Every citizen has the legal obligation to inform CBB in the case of migration. Migration data from 2004-2012 by sex and age groups for five years will be used to identify the age groups where values of peak net migration in Suriname and its central regions exist. This identification of age groups with peak migration enables to make a better choice of age segments with high values of net migration. The classification of the age groups with relatively high net internal and international migration for Suriname and its central regions by age group and sex for the period 2004 – 2012 is performed by using the figures in ANNEX B (FIGURE B.1, FIGURE B.2, FIGURE B.3, and FIGURE B.4). These data reveal that relatively high net internal migration (positive or negative) for both sexes occurs on average in the age groups 15 - 19 up to 25 - 29 in the coastal urban area, rural coastal area, and the rural interior area from 2004 - 2012. For the rural coastal area for example in some years relatively, high net migration also occurs in the age groups 30 - 34 up to 35 - 39. Based on these figures the choice will be made for Suriname and its central regions to consider the age groups with peak net migration as to be the age groups of 15 - 19 up to 30 - 34. Concerning international migration, the peak net migration also occurs for the age groups 15 - 19 up to 25 - 29 for the years 2004 - 2007. However, for the years 2008 - 2012 the peak net migration occurs for the age groups 20 - 24 up to 50 - 54.

The international emigration data of Suriname for both sexes by age groups of five-year for the period 2004 - 2012 is from the Centraal Bureau voor de Statistiek (CBS) of the Netherlands. Suriname also registers international emigration data, but the numbers of emigrants from Suriname (CBB) to the Netherlands are much lower than those registrations of immigrants from Suriname in the Netherlands (CBS), (FIGURE B.5, ANNEX B). Regarding internal migration data, the in-migration and out-migration data from Suriname (CBS) will be used.

For the central regions, the internal migration data for both sexes by age groups of 5 years from district to district is available. FIGURE B6 and B7 in ANNEX B presents the total proportion of male and female internal migrants from district to district in Suriname. These figures show that the pattern of migration for the male population in Suriname is different than for the female population. The internal migration curve for the male population has it maximum in the age group 0-4 (values between *0.1299* and *0.1584*) and is a declining curve. However, the internal migration curve for the female population start declining in the age group 0-4 (values between 0.1060 and 0.1268) up to age group 10-14 and then increase again to reach its maximum in the age group 20-24 (values between (values between *0.1394* and *0.1665*). Starting from age group 25-29 the internal migration curve for female population starts declining again. The proportion of female population migration from district to district in the age group 20-24 is higher than for male population for the period 2004-2012. The proportion of internal migrants for the male population for age group 20-24 is between *0.0825* and *0.1056*. The fact that for male and female population there is peak migration in age group 20-24 may also indicate family migration.

The characteristic of the differences in the age pattern of internal migration between the male and female population in Suriname need to be analyzed in another study. To conduct such a study, better registration will be required for internal migration by the female population concerning the male population in the age group 20-24. The high sex ratio at the beginning of life can explain the large proportions of the internal migration in the age group 0 - 4 for the male population.

3.3 Methods

In this dissertation is required for the application of the methodology of the DDMs, a proper declaration of the population and death count data. Hence, a detailed evaluation of deaths and population will be considered in this chapter. Assessment methods that will be used to determine the quality of the population and death count data are the Whipple´s Index, the heaping Index or the Index of concentration on single ages (ICIS), and the measure of Coale & Kisker (1986). Furthermore, the presentation is done of three different DDMs: ***1)*** General Growth Balance (Hill, 1987); ***2)*** Synthetic Extinct Generation (Beneneth and Horiuchi, 1981) and ***3)*** the Hybrid GGB-SEG (Hill, You and Choi, 2001)

3.3.1 Evaluation of quality population and death data

Evaluation of population and death data is the first step that needs to be completed by using the estimation methods of adult mortality through DDMs. There exist some measures of error to evaluate the quality of census and death data. The types of deficiencies in census tabulations of age are **(1)** errors in single years of age, **(2)** errors in grouped data, **(3)** reporting of extreme old age, and **(4)** failure to report the age (Shryock and Siegel, 1980). According to Siegel and Shryock (1980), deficiencies of death statistics based on vital statistics registration systems are present in three cases **(a)** accuracy of the definition of death applied, **(b)** completeness of registration, and **(c)** accuracy of allocation of deaths by place and time. As stated by the authors, the deficiencies in the case of **(a)** and **(b)** barely appear in developed countries. The authors also mention that problem **(b)** is the most fundamental and severe problem in developing countries.

After evaluation of the data quality, it becomes clear which kind of data errors may exist in population and death data. With knowledge of the quality of population and mortality data, it is easy to observe the violation of assumptions for using these methods.

3.3.1.1 Whipple´s Index

The Whipple´s Index is used to evaluate the distortion of declared age data that finishes in the particular digits usually “0” and “5” (Shryock *et al.*, 1980; Hobbs, 2008). For analyzing digit preference the formula for evaluation of census and death count data using the Whipple´s index for age heaping “0” and “5” is:

$$IW = \frac{5*\left[P(25)+ P(30)+P(35)+P(40)........+P(60)\right]}{\sum_{x=23}^{62} P(x)} *100 \quad \textbf{(1)}, \text{ for the digits “0” and “5”}$$

For digit “0” the formula is:

$$IW = \frac{10*\left[P(30)+P(40)+P(50)+P(60)\right]}{\sum_{x=23}^{62} P(x)} *100 \qquad \textbf{(2)},$$

where $P(x)$ is the population of age ending in “0” and “5” (formula **1**) or in “0 “(formula **2**). The United Nations (1955) suggests that the interval of age 23 to 62 years in de denominator of the formula **(2)** can be considered the age limit. Because it eliminates the ages where problems of the declaration are more complicated than the mere preference (Cunha, 2010; Shryock *et al.*, 1980; Hobbs, 2004; 2008). The Whipple´s Index can also be calculated for other intervals of age, depending on the purpose of use.

The GBS of Suriname already has determined the Whipple´s Index for Census 2004 and Census 2012 for the interval of age 23 to 62 years. Therefore, in this dissertation, the results of the Whipple´s index for the population (GBS 2004 and 2012) will be considered. Whipple`s index varies between 100-500, but values below 100 are also possible. Ranges between 100 and 105 indicate no preference for ages ending by “0” and “5” and 500 specifies that a complete report on ages ending by "0" and "5" is performed. TABLE 3.1 presents categorizations of the Whipple´s Index.

TABLE 3. 1: Classification of Whipple´s Index

Values	≤ 105	$(105,110)$	$[110,125)$	$[125, 175]$	$(175,\infty)$
Quality data	Precise data	Less precise data	Acceptable data	Imprecise data	Very Imprecise

Source: United Nations, 1955

3.3.1.2 Coale and Kisker (1986) measure

The Coale and Kisker measure is used to measure the exaggerated declared age at older ages (i.e. the index of Coale and Kisker, 1986) for the Census and death count data. This indicator calculates the proportion of the most aged of the elderly in the extreme age (95+) to the proportion of older persons (70+). For the purpose of this dissertation, also the ratio of 70+ to 60+ (D_{70+}/D_{60+}), 80+ to 60+ (D_{80+}/D_{60+}), and 90+ to 60+ (D_{90+}/D_{60+}) will be calculated for Suriname and its central regions to analyze the population and death count data on exaggeration of declared age. The references should be countries that are considered having good data quality such as the Netherlands, French, Sweden, and Italy (Coale and Kisker, 1986). In this study, it is also significant to use references from the Netherlands Antilles (e.g., Aruba and Curacao) and Cuba, since Suriname is part of the Caribbean and South America as well as, has a small population. According to Luy (2010), the Netherlands Antilles and Cuba belong to group ***I*** [36] of countries within the five-group classification based on the nature of mortality data. Jamaica can be used as a comparison country since it belongs similar to Suriname to group ***II***. However, since in this dissertation adult mortality is analyzed, it is also important to evaluate the data quality of the population and death through the Coale and Kisker (1986) measure. Because in the application of the GGB method for analysis of adult mortality indicators age segments up to 75+ will be used. Furthermore, the application of the SEG method also requires the use of the open-ended interval.

[36] ***Group I*** contains countries with complete and reliable vital registration based on Census data. The age- and sex-specific mortality rates as a basis for the life tables are calculated directly and unadjusted from the officially registered data. ***Group II*** contains countries for which calculation or derivation of age specific death rates is still possible.

3.3.1.3 The index of concentration in single ages

Another measure to analyze the preference of digits of single ages is the Index of age heaping (AHI_i) or the index of concentration on single ages (Jdanov *et al.,* 2008). This indicator allows determining if the preference of age is concentrated in one particular age group.

$$AHI_i = \frac{D_i}{\exp\left(\frac{1}{5} \sum_{y=i-2}^{i+2} \ln(D_h) \right)}. \qquad \textbf{(3)},$$

The variable D_i is the number of deaths or the population and D_h is the number of deaths or population of the five ages in the denominator, whereby the other two inferior and superior regarding the age in the nominator. According to Jdanov *et al*. (2008) the literature has in many cases not clearly described precise criteria for distinguishing between “good” and “bad” data quality, using AHI_i. There for the reference for the death count data should be the list of countries (Netherlands, England, French, and Sweden) considered having good data quality (Coale and Kisker, 1986) and for which Agostinho & Queiroz (2009) calculated the AHI_i indicator for 2000.

3.3.2 Death Distributions Methods (DDM´s)

In this dissertation primary, the General Growth Balance (GGB), the Synthetic Extinct Generations (SEG) and the combined GGB-SEG methods will be used for evaluate the quality and estimation of adult mortality. These methods have been proved to be value for the application to the distribution of deaths post-childhood and work well in case of little net migration (Hill *et al.*, 2005). The methods require that assumptions about the population are made regarding the nature of the typical data errors ***1)*** any change in census coverage had been proportionately constant by age, ***2)*** no age misreporting of the population and deaths, and ***3)*** proportionately constant omission of deaths by age (Hill, You, and Choi, 2009). An important assumption in the use of the methods GGB, SEG, and Hybrid GGB-SEG is that the population does not experience net migration. As has been seen earlier in the case of Suriname net international migration and internal migration are also a fact for the period 2004-2012, and for some year’s net migration is positive and for other years negative. These methods enable to observe the sensitivity of their functioning in relation to migration and other data errors. Besides that, the methods offer the opportunity to determine life expectancy for Suriname and its main regions, obtained after evaluation of death and population data.

3.3.2.1 The General Growth Balance (GGB) method (Hill, 1987)

The GGB method is a generalization of the method of the distribution of death proposed by Brass (1975). The Brass method is based on the relation between rates of entry, exit, and population growth, see equation **4** (Hill, 1987; Hill & Choi, 2004; Hill, You & Choi, 2009). The growth rate r is constant in all age segments and is of a stable population. Further $\frac{N(x)}{N(x+)}$ is the rate of entry of persons in age x ; $\frac{D(x)}{D(x+)}$ the rate of exit of the individual in age x . $N(x)$ is the population which enter in the age group x and $N(x+)$ is the population of age x and more. Furthermore, $D(x)$ is the population who died in the age group x and $D(x+)$ are the deaths at age x and more.

Equation **(4)** represents a linear relation between the rate of mortality and entry

$$\frac{N(x)}{N(x+)}=r+\frac{D(x+)}{N(x+)} \quad , \qquad \textbf{(4)}$$

To have good results for the Brass method it should be assumed that the population is stable, meaning that the population has constant mortality rates in all ages, the fertility rates are constant over time, and the population is close to migration or zero net migration. This method can be generalized to a non-stable population when two or more census enumerations are available (Hill, 1987), and the growth rate of each segment can be calculated from the census counts.

Hill (1987) assumes that the period between the two censuses is t years. Additionally, the intercensal deaths are by age group, and the first census is $k1$ complete, the second census is $k2$ complete, and the deaths are C complete. Furthermore, all these correction factors are constant by age. In general, data collection of the vital events are not accurate; therefore, in many countries (Hill and Choi, 2004; Hill, Choi, and Timaeaus, 2005; Hill, You, and Choi, 2009) these correction factors are necessary. Hill (1987) also argues that the true population and deaths can be expressed regarding the observed population/observed deaths and the completeness factors. The true values of the first and second census are $N1$ and $N2$ respectively, whereby:

$N1 = \frac{N_1^*}{k1}$, and N_1^* is the observed population of the first census; $N2 = \frac{N_2^*}{k2}$ and N_2^* is the observed population of the second census. The real values of the deaths are $D = \frac{D^*}{C}$, whereby D^* are the intercensal deaths. The exponential growth rate $r(x+)$ of the population aged

$x+$ is: $$r(x+) = \frac{1}{t}\log\frac{N2(x+)}{N1(x+)} \;, \qquad \textbf{(5)}$$

The introduction of an adjustment factor $K = 1/C(x)$**,** in Equation **4** results in Equation **6** where $C(x)$ represents the coverage of registration or enumeration of deaths in age x or more.

$$\frac{N(x)}{N(x+)} = r\ (x+) + K\ * \frac{D(x+)}{N(x+)} \;, \qquad \textbf{(6)}$$

Furthermore, the person-years lived by the population age x and over is the geometric mean of the first and second census and can be calculated in the form of equation **7.**

$$N(x+) = t\left[N1(x+) * N2(x+)\right]^{1/2} \;, \qquad \textbf{(7)}$$

The function $N(x)$ in equation **8** represents the entries to the population aged x during the intercensal period, and that is the number of people that have the $x-th$ birthday during the interval. To calculate the number $N(x)$ in equation **8**

the estimation is conducted in the intercensal person years lived PYL [x-5, x] and PYL [x, x+5] by the age groups [x-5 ,x] and [x, x+5], respectively. Where $PYL[x-5,x] = t\left[N1[x-5,x]N2[x-5,x]\right]^{1/2}$ and $PYL[x,x+5] = t\left[N1[x,x+5]N2[x,x+5]\right]^{1/2}$

$$N(x) = \frac{t}{5}\left[N1(x-5,x) * N2(x-5,x) * N1(x,x+5) * N2\ (x,\ x+5)\right]^{1/4} \;, \qquad \textbf{(8)}$$

$$\Leftrightarrow \;\; N(x) = \frac{1}{(k_1 k_2)^{1/2}}\ N^*(x) \,, \qquad \textbf{(8a)}$$

After the substitution of equation **5**, **7 and 8a** in equation **4** we obtain equation **9** of the GGB method. It represents the linear relation between the rates of entry, the growth rate with the rate of deaths.

$$\frac{N^*(x)}{N(x+)} - r(x+) = \frac{1}{t}\ln\left(\frac{k_1}{k_2}\right) + \frac{(k_1 * k_2)^{1/2}}{C} * \frac{D^*(x)}{N(x+)} \quad , \qquad \textbf{(9)}$$

Equation **9** is equivalent to the mathematical linear equation in the form: $Y = A + BX$.

According to (Hill, 1987; Hill and Choi, 2004; Hill, You and Choi, 2009) the intercept $\frac{1}{t}\ln\left(\frac{k_1}{k_2}\right)$ and the slope $\frac{(k_1 * k_2)^{1/2}}{C}$ of equation **9** are used to evaluate data quality. The authors also argue that the intercept covers the error in the growth rate, which is assumed to be constant across ages. Furthermore, a variation of coverage of both censuses is explained by the intercept, while the degree of coverage of registration or enumeration of deaths regarding the mean of the coverage of both censuses is explained by the slope.

Furthermore, the ratio $\frac{k_1}{k_2} = \exp(t\,A)$ expresses the coverage of the first Census in relation to the second Census, indicating the coverage differential between both censuses. When growth rates are positive over each age x the bias in the method of the estimate of k_1/k_2 overestimates this ratio. In the case of negative growth rates it underestimates the ratio. In the case of overestimating k_1/k_2 it is considered a minimum and, on the other hand, underestimating is a maximum (Hill, 1987).

Hill (1987) mentioned that the objective of the GGB method is estimating adult mortality by obtaining consistent denominators and numerators for the central age-specific mortality rates. To achieve this, we can set k_1 or k_2 to unity. After that, the remaining two factors regarding k_1 or k_2 can be estimated.

The intercept can assume positive and negative values close to zero while the slope only assumes positive values between zero and one, one or greater than one but, in general, less than one and a half. TABLE 3.2 explains the interpretation of the different values of the intercept and slope of the GGB method based on the linear equation.

TABLE 3. 2.: Explanation of the intercept and slope of GGB method (Hill, 1987)

INTERCEPT = $\frac{1}{t}\ln\left(\frac{k_1}{k_2}\right)$			**SLOPE =** $K = \frac{(k_1 k_2)^{1/2}}{C}$		
Positive	**Negative**	**Zero**	$0 < K < 1$	$K = 1$	$K > 1$
$k_1 > k_2$	$k_1 < k_2$	$k_1 = k_2$			
Coverage first Census better second Census	Coverage second Census better than first Census	Coverage first Census is equal second Census	Under – registration of deaths regarding population	Completeness of population recording relative to death recording	Over registration of deaths regarding the population

Source: Own elaboration based on methodology GGB (Hill, 1987)

When the intercept is positive, the census coverage change is more than the unity, and when the intercept is negative, the census coverage change is less than the unity. The census coverage change and the intercept (error in the growth rate) are inverse operations and thus related to each other. In the same way, the slope K is the adjustment factor for the deaths, and the estimation of the coverage of death recording relative to an average of the coverage of the two censuses is the inverse relation of the completeness of death registration concerning the population.

3.3.2.2 The Synthetic Extinct Generation (SEG) method (Benneth and Horiuchi, 1981) and the Hybrid GGB-SEG method (Hill, You and Choi, 2004)

Hill, You, and Choi (2009) mention that the SEG method (Bennett and Horiuchi, 1981, 1984) is derived from the method of death distribution developed by Preston *et al.* (1980) and is based on the insight of Vincent (1951). According to the idea of Vincent (1951) in a closed population with a perfect recording of deaths, the population age *a*, at time *t* could be estimated by accumulating the deaths to that cohort after time *t* until the group was ***extinct***. Formula **10** represents the equivalence to the life table relationship.

$$l(a) = \sum_{x=a}^{\bar{w}} d(x) \quad , \qquad \textbf{(10)}$$

The estimated population at age *a*, is calculated by using equation **11**.

$$\hat{N}(a) = \int_{x=a}^{\bar{w}} D(x)\, e^{\int_a^x r(y\,dy)}\, dx \quad , \qquad \textbf{(11)}$$

The completeness of death recording assumed to be constant at all ages, proportionate to census coverage is estimated by formula **12**. The population $N^0(a) = \frac{1}{5}\sqrt{{}_5 N1^0_{a-5} * {}_5 N2^0_a}$ is the observed population of age a.

$$\hat{c}(a) = \frac{\hat{N}(a)}{N^0(a)} = \frac{\int_{x=a}^{\bar{w}} D(x)\, e^{\int_a^x r(y\,dy)}\, dx}{N^0(a)} \quad , \qquad \textbf{(12)}$$

The integral of the growth rate for five-year age groups is determined as follows:

$$\int_a^x r(y)\,dy = 5 * \sum_a^x {}_5 r_y + 2.5\ {}_5 r_x \quad , \qquad \textbf{(13)}$$

The estimated coverage of deaths above age a compared with population is given by $\hat{c}(a)$. In other words, the SEG method calculates the estimated population that is composed of a sum of those who died multiplied by the sum of the growth rates of the population in each age group. The SEG method just as the GGB method compares the distribution of the living with those who died. The completeness of death recording is the relation between the estimated and the observed population.

Accordingly, Hill, You, and Choi (2009), Bennett and Horiuchi (1981) generalized the SEG method to the non-stable closed population. The authors use age-specific growth rates and have the additional assumption of constant coverage of population across time. The SEG method adopts the other assumptions of the method of Preston *et al.* (1980) which are the same as the Brass method. GGB and SEG methods give good estimates in the presence of data errors (Hill, 2000).

According to Bennett and Horiuchi (1984), use of the SEG method requires an estimate of life expectancy at the age of the open-ended interval. The authors suggest also to derive estimates from the ratio ${}_{30}d_{10}$ and ${}_{20}d_{40}$ of death data (the relationship between younger adult deaths and older adult deaths) to calculate life expectancy of the open-ended interval. There after tables based on regression for the West Princeton life table (Coale, Demeny and Vaughan 1983) produced by (Bennett and Horiuchi, 1984) are looked up. In this dissertation, for use of the SEG and combined GGB-SEG method life expectancy at 80 (open-ended interval) for male and female is considered for Suriname. Additionally, for the central regions life expectancy for the open-ended interval 85+ is used.

The GGB-SEG procedure uses the intercept estimate of GGB to adjust the data for the estimated census coverage change, adjust the intercensal deaths with the factor C and then applies the SEG approach (Hill, You and Choi, 2009). The census data is thus multiplied by the factor, $\frac{k_1}{k_2} = \exp(At)$ and the intercensal deaths are divided by the factor C (Hill, 1987). This operation makes the data consistent.

In conclusion, the GGB and SEG method work well when the errors for which they are developed are the only ones present in the data (Hill and Choi, 2004). According to Hill and Choi (2004), the GGB method has the advantage that it allows systematic errors and change in Census coverage while the SEG method is less sensitive to age misreporting or differential coverage by age than GGB method.

Hill, You, and Choi (2009) observe that countries with net migration applying both GGB and SEG method can, therefore, fit the age range 30+ to 65+ or 35+ to 65+. The effect of net migration is diminished starting with high age for the proper range. The justification for the use of these intervals is because, in the age groups of young adult years (15-19 up to 35-39), there is often a peak migration rate (Preston *et al.*, 2000; Hill, You and Choi, 2009).

3.3.2.3 Age segments and Migration

For the purpose of this dissertation two clusters of age segments will be considered: ***1)*** age segments ***including*** high net migration (5+ to 65+, 15+ to 65+, 10+ to 60+, 15+ to 55+ and 15+ to 75+) and ***2)*** age segments ***excluding*** high net migration (30+ to 55 +, 30+ to 60+, 30+ to 65+, 30+ to 75+, 35+ to 65+ and 35+ to 75+). The division in clusters of age segments will enable to see the effect of migration on the results of the completeness of death register. As seen in paragraph 3.2 peak migrations occur in Suriname and its main regions for the young adult age groups from 15 - 19 up to 30-34 or 35 - 39.

The GGB and SEG methods give different responses to migration, whereby SEG is strongly affected by emigration, tending to underestimate death and overestimate mortality (Hill and Choi, 2004; Dorrington *et al.*, 2011). According to Hill *et al.* (2009), the GGB, SEG and combined GGB-SEG methods underestimate coverage (overestimate adjusted mortality) in populations affected by immigration. The GGB method is more sensitive to coverage errors that change with age (Hill *et al.* (2009). The SEG method combined with the GGB method is the safest choice in the absence of other information about error patterns (Hill, You, and Choi, 2009). The authors argue this based on the two population scenarios they built by using different initial non-stable population, mortality and fertility rates and project the population for a simulated intercensal interval of five years. After that, they test the performance of the DDM´s when there are data errors or their assumptions are not met in the case of building two error sets (error set I and II) with six data-error categories in each projected population. The data error category consists of ***1)*** census coverage change, ***2)*** death omission, **3)** age misreporting, ***4)*** age-varying coverage of Census, ***5)*** age-varying coverage of death, and ***6)*** emigration or immigration.

Hill, You, and Choi (2009) performed simulations for each error type with all other data correct, instead of testing all possible combinations of error categories. The authors made that choice with the objective to identify the effect of earlier mentioned data errors on its own and then combined error types in groups that are based on expectations of how data errors would happen in practice.

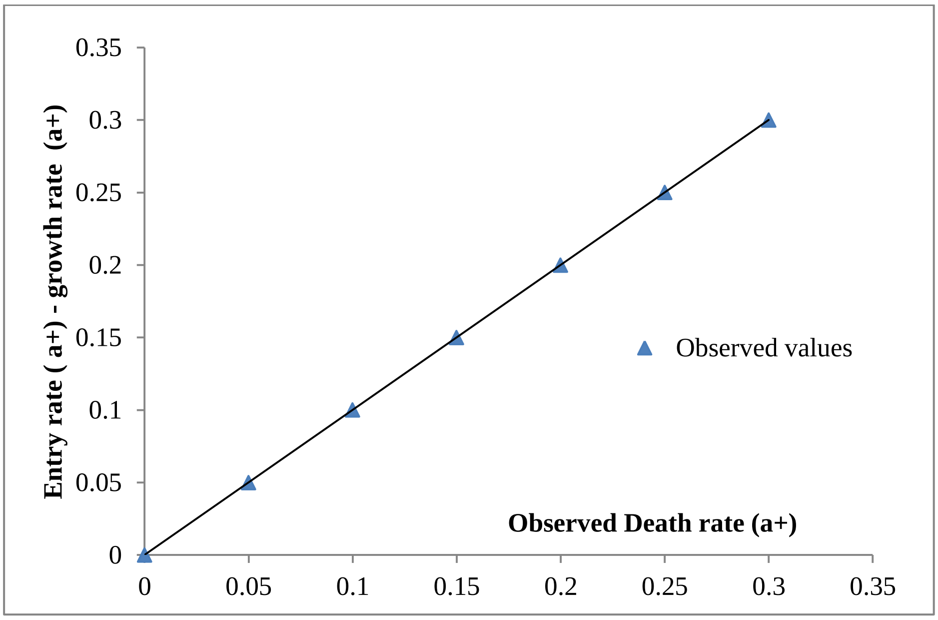
As a result, they had 24 selected data error patterns in each of the two error sets and for both errors sets 96 error simulations were conducted. Hill, You and Choi (2009) found that the Extended SEG method was the closest to the correct answer in 16 out of 25 scenarios, whereas the Combined GGB-SEG approach was closest to only nine. On the other hand, for Dorrington *et al.* (2008) in their scenarios of data error types, the Extended SEG is closest to the correct answer in 15 out of their 23 scenarios, while the combined GGB-SEG is the closest in five. In this dissertation, it is not possible to measure death omission, age varying of the census and death data because no reference scenario is used. However, the methods give the sign that the errors may exist through the diagnostic plots.

Diagnostic plots of the GGB and SEG method provide information in case of existence on age misreporting of population and death, age varying census coverage, as well as the presence of emigration and immigration. In other words, the diagnostic plots enable the examination of the performance of methods by error type (Hill and Choi, 2004). As Queiroz and Sawyer (2012) and Dorrington (2011) suggest the diagnostic plots of the SEG and GGB-SEG methods need to present constant coverage for all age intervals. According to Hill, You, and Choi (2009) it is reasonable when applying both GGB and SEG to fit the age range 30+ to 65+ in populations affected by migration.

The diagnostic plots by the GGB method are used to assess the goodness of fit (Hill, Choi, and Timaeus, 2005). As the authors mention, for the GGB method the vertical scale represents the difference between the entry rate a+ ($N^*(a)/N^*(a+)$ and the growth rate a+ ($r(a+)$. The horizontal scale represents the observed death rate a+ ($D^*(a+)/N^*(a+)$). The diagnostic plot of GGB method (FIGURE 3.5) in case of no data error is a line passing through the origin and a line of 45 degrees whereby for all the points the next relationship is valid: $N^*(a)/N^*(a+) - r(a+) = D^*(a+)/N^*(a+)$

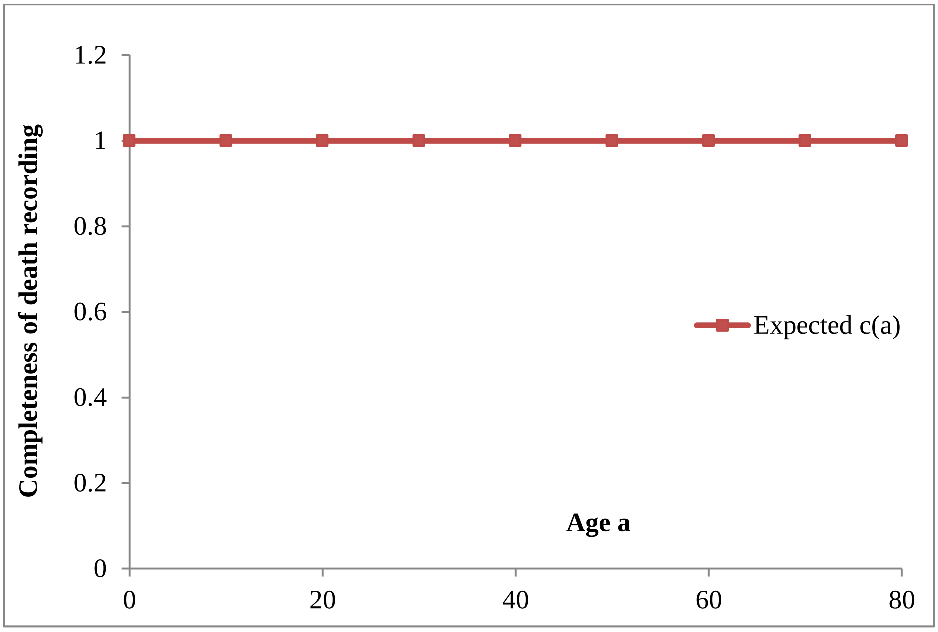
The diagnostic plot of the SEG and GGB-SEG in the case of no data errors is presented in FIGURE 3.6. On the horizontal axis, the age segment a + is placed and on the vertical axis completeness of death recording regarding the population $c(a)$ is presented. In the case of completeness of death reporting, the reference is 100%, and the plot is a horizontal line with $c(a)=1$ for all the ages.

FIGURE 3. 5: Application of the GGB method in case of no errors



Source: Own elaboration based on methodology GGB (Hill, 1987)

FIGURE 3. 6: Application SEG and GGB-SEG method in the event of no data errors



Source: Own elaboration based on methodology Benneth and Horiuchi (Hill, 1981) and Hill, You and Choi (2009)

First of all, in this dissertation, diagnostic plots of the GGB method for the age segment 5+ to 65+ will be presented. For the Extended SEG, the age segment 15+ to 55+, the summary index of adult mortality is considered for the draw of the diagnostic plot. Also the diagnostic plots for the combined GGB - SEG for some age segments ***including*** and ***excluding*** peak proportion of migration will be presented. The expectation is that making diagnostic plots by using the GGB, SEG, and GGB-SEG method as well as utilizing the two clusters of age segments, clear differences in results will be presented in the case of the ***presence*** or ***not of migration*** and ***other data errors***. Hill, Choi, and Timaeus (2005) mention, the SEG method is much more sensitive to slight changes in census coverage that distorts the growth rates.

3.3.2.4 The General Growth Balance (GGB) opens to migration

The GGB method opens for migration proposed by Bhat (2002) and by Hill and Queiroz (2010) will also be presented, but not adopted in this dissertation. GGB methods have the primary limitation of the assumption of a closed population. The GGB methods open to migration make it possible to consider migration in the estimation of adult mortality.

3.3.2.4.1 General Growth Balance open to Migration (Bhat, 2002)

According to Bhat (2002) the general growth model for populations open to migration can be written as:

$$r\ (a+) = b\ (a+) - d\ (a+) + m(a+)\quad , \qquad \textbf{(14)}$$

Whereby $r(a+)$ represents the population growth rate for the open – ended age interval, $b(a+)$ is the birthday rate in that range, $d(a+)$ is the death rate and $m(a+)$ is the net migration rate for the population aged a and over. Equation **14** can be rewritten as:

$$b\ (a+) - u(a+) + v(a+) = r(0+) - m\ (0+) + d\ (a+)\ , \qquad \textbf{(15)}$$

Whereby $u(a+) = r(a+) - r\ (0+)$ is the "***partial growth differential***" and $r(0+)$ is the growth rate of the total population. Furthermore, $v(a+) = m(a+) - m\ (0+)$ is the ***"partial migration differential"*** where $m\ (0+)$ is the net migration rate of the total population. According to Bhat (2002), the term $u(a+) - v(a+)$ in equation **15** is the net correction needed for the effects of varying growth rates and disturbances from migration. This term can also be viewed as the partial growth differential that would have been observed if there was no migration. In the study of India (Uttar Pradesh) for males 1981-1991, which was conducted by Bhat (2002) the adjustment for migration raises the net corrections at ages lower that 30+ while it reduces them at ages higher than 30+.

The assumption for applying Bhat (2002) is that the level of under-reporting of deaths is constant across all ages results in:

$$d\ (a+) = \frac{d*(a+)}{C}\quad , \quad \textbf{(16)}$$

where $d^{*}(a+)$ is the partial mortality rate at ages a and over, which computed from the reported deaths. Rewriting equation **15** results in:

$$\{b(a+) - u(a+) + v(a+)\} = n + \frac{1}{C} d^{*}(a+)\quad , \qquad \textbf{(17)}$$

whereby n is the rate of natural increase of the population. According to Bhat (2002), equation **17** enables the calculation of completeness of death recording (C) from the slope. The rate of natural increase of the population n can be inferred from the intercept of the line. Moreover, application of Equation **17** requires data on intercensal migration.

The diagnostic plots of the GGB method (Hill, 1987) for age segment 5+ to 65+ ***including*** age segments with peak net migration and the GGB (Bhat, 2002) plot age segment 5+ to 65+ may make it possible to observe differences in the migration effect.

3.3.2.4.2 General Growth Balance method for Migration (Hill and Queiroz, 2010)

The General Growth Balance method for migration of Hill and Queiroz (2010) uses the estimation of net migration rates primarily. In addition, they utilize a model of age-specific migration and then compare the observed death rates over successive ages against residual estimates. This residual estimate is made up of the entry rate plus the net migration rate minus the growth rate.

According to Hill and Queiroz (2010), this method is developed on the observation that migration rates have a different age pattern from death rates. Additionally, the authors mention that only when the condition mentioned before is true, net migration and deaths can be distinguished. In a population that has good data and high net migration rates according to Hill and Queiroz (2010), the method works well. The authors apply the method to the male population of Mexico (1990 - 2000) and Puerto Rico (1980 - 1990).

To use the GGB method open for migration the authors consider equation **14** derived by Bhat (2002) and rewrite it in the form of equation **18** regarding net migration rates that have a typical age pattern ${}_5nm^s{}_x$:

$$r\ (a+) - b\ (a+)\ + d\ (a+) = k_{nm} + q_{nm} * nm^s(a+)\ , \qquad \textbf{(18)}$$

$$nm^s\ (a+) = \sum {}_5nm^s{}_x * {}_5PYL_x / \sum {}_5PYL_x\ , \qquad \textbf{(19)}$$

To solve equation **19,** a set of model net migration rates ${}_5nm^s{}_x$ is required. The authors suggest the Rogers and Castro (1984) model. This model proposed a simplified migration model with the intention to represent a gross migration flow generated by labor force mobility. The migration at age x is given by $m(x)$:

$$m(x) = 0.02 * \exp(-0.1 * x) + 0.1 * \exp(-0.1 * (x - 20) - \exp(-0.4 * (x - 20)))\ , \qquad \textbf{(20)}$$

As mentioned by Hill and Queiroz (2010) and Rogers and Castro (1984), the model combines an exponentially decaying incidence of child migration with a double exponential to represent

q_{nm}

the rapid increase and more gradual decline of the migration of those participating in the labor market.

Considering equation **18** the constant relates the quantum of migration at the standard rate set to the quantum of migration in the actual population. Furthermore, PYL is the person years lived and it is a constant.

The slope in equation **18** is q_{nm}.

The adjusted values of $k_{nm} + q_{nm} * nm^{s}(a+)$ are replaced in equation **14** and become:

$$b(a+) - r^{0}(a+) + (k_{nm} + q_{nm} * nm^{s}(a+)) = (1/t)\ln(k) + q_{d} * d^{0}(a+) \ , \qquad \textbf{(21)}$$

The authors suggest that the values q_d should be close to one. In case the result q_d is different from 1 the first estimation from equation **19** can be used to recalculate $d(a+)$ in equation **14** and then re-estimate q_{nm} until q_d converges to a fixed value.

4. EVALUATION DATA QUALITY FOR POPULATION AND DEATH FOR SURINAME AND ITS MAIN REGIONS 2004-2012

This chapter presents primary results of the evaluation of the population and death count data for Suriname from 2004 - 2012 using the different measures and index presented in paragraph 3.2.1 of chapter 3. Secondary the same exercise is done for the main regions of Suriname for population and death count data from 2004 - 2012.

4.1 Evaluation data quality of the population data for Suriname

The Whipple´s Index, Coale and Kisker (1986) measure and the index concentration in single ages are applied to the population data of Suriname for Census 2004 and 2012

4.1.1 Whipple´s Index male and female population

The results of the Whipple´s Index for Suriname reveal that the Census data of 2004 and 2012 present for male and female population values below 105 which reveal that the data is very good. Values out of the acceptable interval (greater than 125) indicates that there exist a possibility on erros of age or sex, or selective missed and or age or sex of not registered migration (GBS, 2013).

4.1.2 Coale and Kisker measure male and female population

With respect to the analyse of the Coale and Kisker (1986) measure the results of Suriname for the census 2004 and census 2012 are presented in TABLE 4.1. These values are compared to the values of the islands Aruba, Curaçao, Cuba, Jamaica, and the countries the Netherlands, Sweden, France, and Italy (TABLE B 1.1, ANNEX B1), which are considered to have good data according to Luy (2010).

TABLE 4. 1: Coale and Kisker (1986) measure for population of Census 2004 and 2012 for Suriname

		Suriname	**Census 2004**	
SEX	**P95+/P70+**	**P80+/P60+**	**P90+/P60+**	**P70+/P60+**
Female	0.0099	0.1193	0.0114	0.4436
Male	0.0045	0.0943	0.0168	0.4249
		Suriname	**Census 2012**	
SEX	**P95+/P70**	**P80+/P60+**	**P90+/P60+**	**P70+/P60+**
Female	0.0104	0.1448	0.0196	0.4694
Male	0.0058	0.1220	0.0137	0.4462

Source: GBS Census data Suriname 2004 and 2012

As can be seen the results for Suriname for male and female population in TABLE 4.1 produce higher values for Census 2012 in relation to Census 2004 for nearly all the groups. Except for the group P90+/P60+ of the male population the value for census 2012 is lower than for census 2004. Furthermore, the results for the female popuation of Suriname are the closes to the data of Aruba, Curacao and the Netherlands for group P95+/P70+ for Census 2004 and 2012. However, for the group P80+/P60+ the female data for both censuses is the closests to Aruba. Aanalyzing the data of the female population for the groups P90+/P60+ and P70+/P60+ we observe that the results of the Coale & Kisker measure for Suriname (Census 2004 and 2012) result in values close to Curacao and Aruba, respectively.

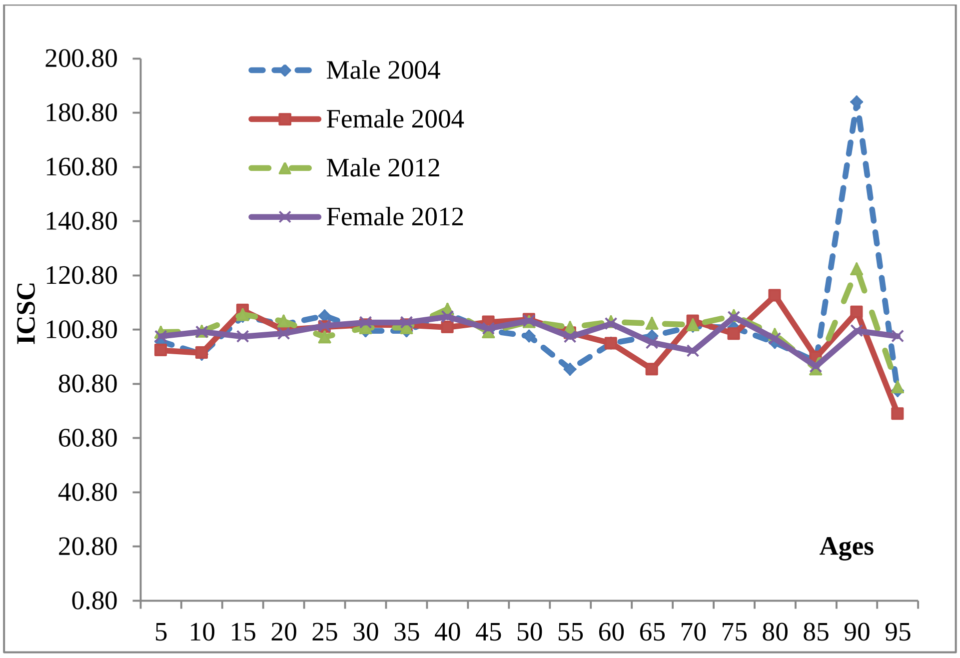
The analyze of the male data in TABLE 4.1 reveal that the results of Suriname for both census are close to the data of the Netherlands for the groups P95+/P70+ and P80+/P60+. For group P90+/P60+ the male data of Suriname is close to data of Curacao and the Netherlands. Finally the male data for group P70+/P60+ is closest to the data of the Netherlands and Curacao. Resuming male and female data of Census 2004 and 2012 of Suriname reveal that exageration of age does not occurred so the data quality is reasonable to good. It seems thus that age is well informed. This affirmation can be done based on the fact that the results of the data of Suriname are close to the data of Netherlands, Aruba and Curacao which are countries with complete and reliable vital registration based on census data (Luy, 2010). How exageration of age in many populations occur the Coale and Kisker measure is also a way to investigate the level of error in reporting of age.

4.1.3 Index Concentration on Single ages for male and female population

The results of the age heaping index for the population of Suriname by sex for Census 2004 and 2012 in FIGURE 4.1 are considered to be good for the ages ending in “0” and “5” for young and adult ages .

The values for the age 90 for male population of census 2004 and 2012 present the highest values, indicating exageration of age. But on the other hand in Suriname the male population at advandce ages is very small. The conclusion of age exageration at 90 years for male in Suriname can thus be attributed to the small scale of the population and the real exageration of age. The high values at older ages for male population indicate preferences for the age 90 in both censuses

FIGURE 4. 1: Index concentration in single ages for population Census 2004 and 2012 by sex for Suriname



Source: GBS Census data Suriname 2004 and 2012

For female population relatively high values of the heaping index are encountered for the age 80 and 90 in census 2004 in relation to the other ages. Moreover, for female popualtion the preference for age 80 occurs only in Census 2004. Overall, population data from Suriname in the period 2004-2012 is of good quality.

4.2 Evaluation data quality of the death counts data for Suriname

The Whipple´s Index, Coale and Kisker (1986) measure and the index concentration in single ages are applied to the mean of the death count data of Suriname for the period 2004-2012.

4.2.1 Whipple´s Index death count data for male and female

The evaluation of data quality of death count for Suriname is primary presented by applying the Whipple´s index. For the data by sex preliminary results are from 2009 - 2012 and for both sexes results are from 2006 - 2012. Female results with respect to death counts data in Suriname are acceptable (no attraction for the digit 0 and 5) for the age groups 23 - 77, 23 - 87 and 23 - 97. For age groups 23 - 62 and 78 -97 the data is precise for female population and for the other age groups in TABLE 4.2 data it is acceptable. With respect to male results of deaths for Suriname it can be observe that results are better in the sense that for three age groups (23 - 62, 23 - 97 and 78 - 97) data is precise. For the age group 23 - 87 death counts data for male population is less precise and for age groups 58 - 77 and 23 – 77 death counts data is acceptable. For both sexes results of death register applying the Whipple´s Index for digit “0” and “5” can be considered for some age groups precise (23 - 62, 58 - 77 and 78 - 97) for others less precise (23 - 97) and acceptable (23 - 77).

Remarkable is that results of the Whipple´s Index for digit “0” in TABLE 4.2 present imprecise data for the female population and both sexes in the age group 23 - 77 and 23 - 87. However for male population there is not any age group which presents imprecise data. The conclusion can be made that quality of the death count data for male and female population on country level present in most of the age groups between acceptable and precise data. Data for the male population presents better results of the Whipple´s Index for digit “0” and digit “0” and “5”.

TABLE 4. 2: Whipple´s Index for death count data of Suriname 2006-2012 (both sexes) and 2009-2012 (by sex)

DEATHS	WHIPPLE INDEX		Country	DEATHS	WHIPPLE INDEX	Country	
	2009-2012	2009-2012	2006-2012		2009-2012	2009-2012	2006-2012
Age	DIGIT " 0"	DIGIT " 0"	DIGIT" 0"	Age	DIGIT "0" and "5"		DIGIT "0" and "5"
	Female	Male	Both sexes		Female	Male	Both sexes
23-62	115	102	109	**23-62**	102	100	102
23-77	134	122	128	**23-77**	122	114	117
23-87	127	111	119	**23-87**	117	105	110
23-97	111	103	108	**23-97**	110	103	106
58-77	96	101	97	**58-77**	113	99	101
78-97	122	120	128	**78-97**	98	91	99

Source: CBB death data Suriname 2006-2012

4.2.2 Coale and Kisker (1986) measure death count data for male and female

The second measure that is used to evaluate the data quality of the death counts is the Coale and Kisker (1986) measure. TABLE 4.3 represent the results by applying the Coale & Kisker measure for the data of the death for Suriname by sex. Differences between both sexes for the different age groups exist. The quality of the death counts data for man and woman are compared with the results of the death count data of the Netherlands for the period 1999 - 2001 (presented in the dissertation of Agostinho (2009), period of 2000-2005 and 2005-2010, data of the United Nations (World Population Prospects, 2012). The comparison of the death counts of Suriname is also done with death counts data of 2000 - 2005 and 2005 - 2010 of Curacao, Aruba, Cuba and Jamaica[37] (TABLE B2 and TABLE B3, ANNEX B). For Suriname the values of death count data applying Coale & Kisker (1986) are below the values of the Netherlands for male and female population (1999-2001) for the groups 70+/60+, 80+/60+ and 90+/60+. For the period 2000-2005 and 2005 -2010 the results of the Netherlands age groups 95+/70+, 70+/60+, 80+/60+ and 90+/60+ are also higher than the values of Suriname. These results mean that the percentage of deaths for each group in Suriname does not present exaggeration of age at death. It is also important to consider that the percentage of the elderly (population 65+) in Suriname was 7.06 % in 2012 (GBS, 2012) that is 55.85% less than the percentage of the elderly (population 65+) in 2012 in the Netherlands of 16 %[38]. Further another important aspect to consider is that Suriname has a small population (less than one million of habitants) and there for has a smaller proportion of elderly in relation to the Netherlands.

Comparing the results of the quality of death counts by applying Coale & Kisker (1986) for Suriname we observe that the values of Suriname are the closest to the values of Aruba, followed by the values of Curacao. For the other Caribbean countries Cuba, and Jamaica it is obvious that for male and female population the values of Suriname are in some age groups nearly half time less. For example for Suriname for the female population the result of D90+/D60+ is *0.0936*, while for Cuba and Jamaica for 2005-2010 it is respectively *0.1951* and *0.1766*. It important to observe that Cuba is in an advance stage of ageing process compared to Suriname, which mean that the number of death in the group D90+/D60+ will be higher. In TABLE B2 (ANNEX B) we observe that for D70+/D60+ the Coale & Kisker measure for 2000 - 2005 for the male population for Aruba *0.8002* is and for Curacao *0.8173* is, while for Suriname the value is *0.6898* (see TABLE 4.3). Aruba and Curacao are considered to have good civil register in relation to Suriname according to Luy (2010).

[37] World Population Prospects 2012
[38] http://www.nationaalkompas.nl/bevolking/vergrijzing (23-02-2015)

TABLE 4. 3: Results of Coale and Kisker (1986) measure for average of death count data of Suriname, 2004-2012

SEX	**D100+/D80+**	**D100+/D70+**	**D95+/D70**	**D80+/D60+**	**D90+/D60+**	**D70+/D60+**
Female	0.0163	0.0085	0.0382	0.3901	0.0936	0.7522
Male	0.0101	0.0042	0.0197	0.2885	0.0513	0.6898

Source: CBB death count data Suriname 2004-2012

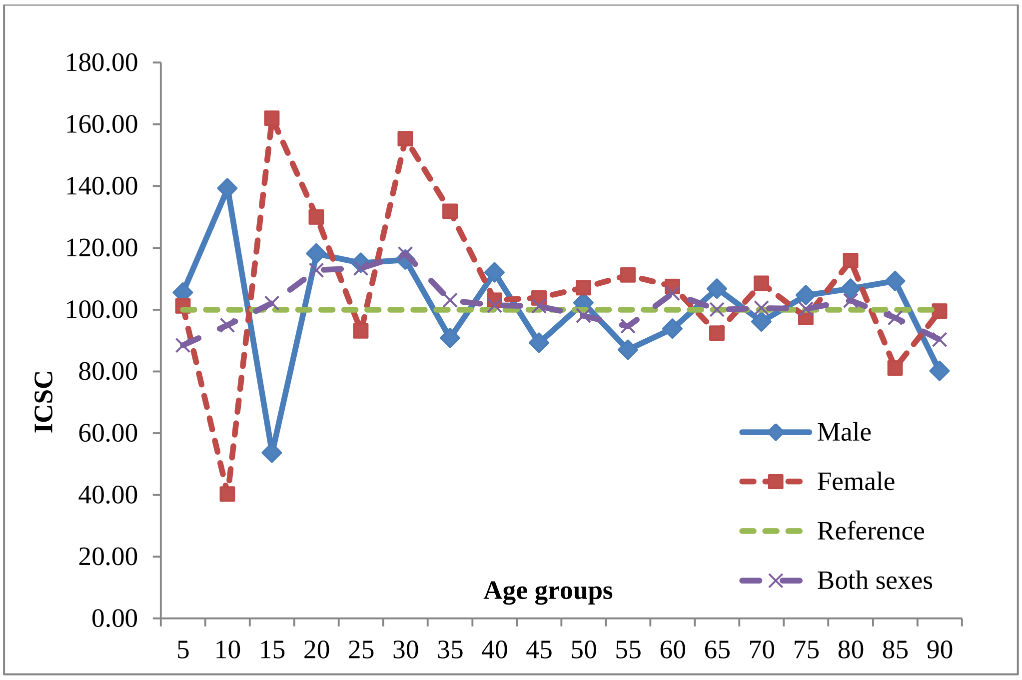
4.2.3 Index Concentration in Single Ages death count data male and female

The third measure used to analyse the death count data for Suriname is the Index Concentration on single ages for digit "0 "and "5" for male and female population and for both sexes. FIGURE 4.2 presents the results. As we see for female population of Suriname preference of age at death is observed for the ages 15 and 30 years with the values 161.99 and 155.34, respectively. For age 10 at death for the female population the preference is 40.26 which is much less than for age 15 and 30. For the male population of Suriname on the other hand the preference for the age at death for 10 years is 139.24 and the age of 15 years presents a small preference of 53.61. The female population of Suriname presents higher levels of preferences of the age at death than male population. Possible explanation may be: ***1)*** not correct declaration of the age at death for female population; ***2)*** Error in the birth certificate of the female death, due to late registration at birth by the relatives. In the study of Brazil done by Agostinho (2009) she mentioned that the minimum value of ICSI of death for developed countries was for female and male 76 and 73 and the maximum was 150 and 121, respectively[39]. In case of the study of Brazil the minimum values were for male and female population 50 and 27. The maximum values for Brazil are for male and female population 180 and 150, respectively. The minimum values for male and female population for Suriname are out of the range of the developed countries, but close to the range of Brazil.

The evaluation of the population data for female population using the Whipple`s Index (digit "0" and "5") also shows that the data is reasonable for census 2004 and 2012 for the age group 23-77. The advantage of the ICSI is that it detects possible exaggeration of specific ages, while the Whipple´s index reveals possible exaggeration of age declaration for groups.

[39] The minimum and maximum values, by sex are for the period 1999 - 2001 for some developed countries; For Brazil the minimum and maximum values, by sex are also for the period 1999 - 2001.

FIGURE 4. 2: Index concentration in single ages of death count data for male and female population (2009-2012) and both sexes (2006-2012) in Suriname



Source: CBB data

Finally it can be concluded that the quality of the death count data for Suriname is reasonable good, based on the results of the Whipple´s Index, Coale and Kisker measure. Using the ICSI some ages of death show some preferences for male and female population. However for both sexes there is no or small preference for the age at death. It is important to remember that the death counts by sex is for 2009-2012 (***period of 4 years***) and for both sexes it is for 2006-2012 (***period of 7 years***).

4.3 Evaluation data quality of the population for main regions of Suriname

In this paragraph the results of the Whipple´s index, Coale and Kisker (1986) measure and Index Concentration in single ages are presented for the urban coastal, rural coastal and rural interior area for the period 2004-2012

4.3.1 The Whipple´s Index for male and population of the main regions of Suriname

For Census 2004 we calculated based on data of CBB the Whipple´s Index for digit “0” and “5” of the male and female population of Suriname and for the age group 23 - 62. As the results show the quality of the Census data 2004 is good for all the main regions, because the results are below 105. According to the General Bureau of Statistics in Suriname the census data of 2012 can be considered good for the central regions of Suriname based on the results of the Whipple´s Index "0" and "5", calculated for the age group 23-62. TABLE 4.4 shows the results of the Whipple´s Index for the main regions of Suriname in Census 2004 and Census 2012.

TABLE 4. 4: Whipple´s Index for central regions of Suriname, Census 2004 and 2012

REGIONS	***CENSUS 2004***			***CENSUS 2012***		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
Urban Coastal	101.35	103.47	102.42	101.72	102.64	102.19
Rural Coastal	95.65	99.47	97.43	100.86	99.28	100.12
Rural Interior	103.68	96.33	99.98	103.98	100.30	102.08

Source: General Bureau of Statistics, Census 2004 and 2012

4.3.2 Coale and Kisker measure (1986) for male and female population of the main regions of Suriname

TABLE 4.5 presents the results of the Coale and Kisker measure (1986) for the central regions in Suriname for Census 2012. The results reveal for the female population that the value for group P95+/P70+ is the highest (*0.1169*) in the urban coastal area and the lowest (*0.00626*) in the rural coastal area. For the male and female population on the other hand the highest value for group P80+/P60+ is in the rural interior area, *0.13907* and *0.16511*, respectively. This result reveals bigger exaggeration of age for male and female population in the group of the eldest of the elderly in the rural interior area. It is important to stress that the male and female population in Census 2012 of the rural interior area were 35.776 and 35.492, respectively. This result expresses that the rural interior area with a smaller population (13.16% of the total population in Census 2012) has in comparison to the urban coastal and rural coastal area relatively more elderly population.

TABLE 4. 5: Coale and Kisker (1986) measure for the population in the main regions of Suriname, Census 2012

	Urban	Coastal	2012	
SEX	**P95+/P70+**	**P80+/P60+**	**P90+/P60+**	**P70+/P60+**
Female	0.01169	0.14617	0.02101	0.46461
Male	0.00568	0.12125	0.01356	0.44437
	Rural	**Coastal**	**2012**	
SEX	**P95+/P70+**	**P80+/P60+**	**P90+/P60+**	**P70+/P60+**
Female	0.00626	0.12643	0.01193	0.46927
Male	0.00534	0.11656	0.00868	0.43380
	Rural	**Interior**	**2012**	
SEX	**P95+/P70+**	**P80+/P60+**	**P90+/P60+**	**P70+/P60+**
Female	0.00959	0.16511	0.02302	0.49761
Male	0.00751	0.13907	0.02540	0.48518

Source: General Bureau of Statistics, Census 2012

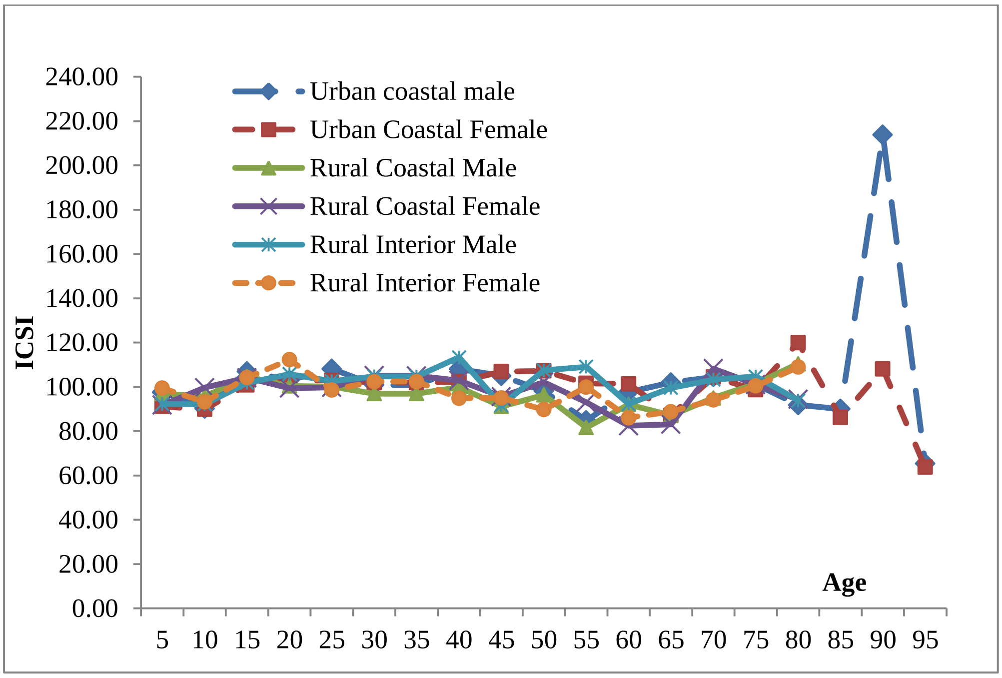
Another prove of exaggeration of age in the group of the eldest of the elderly is the result of P90+/P60+ for the male population in the rural interior area. Beside that there were two more men of 90+ in relation to women in every 1000 persons of 60+ years in the rural interior area, which is in demographic terms not common. It is expected that for the population ratio 90+ to 60+ there are in general more women than man alive, based on advantage of death for women at older ages. For group P70+/P60+ the value is the highest for the female and male population in the rural interior area compared to the values of the urban coastal and rural interior area, *0.49761* and *0.48518*, respectively.

Comparing the results of the main regions of Suriname with the reference countries we observe that for the female population the values of Coale & Kisker are close to the values of Curacao, Aruba, Netherlands depending on the group presented in TABLE 4.5. For the male population the values of Coale and Kisker are for some groups (e.g. P95+/P70+) close to the value of France, Sweden and Italy in the reference TABLE B1 (ANNEX B). The value of group P90+/P60+ for the rural interior area is close to the value of Cuba and Jamaica. On the other hand the values for the male population in group P70+/P60+ for the central regions of Suriname are close to the values of the Netherlands, Curacao and Cuba. This result expresses the degree of the aging process in the main regions of Suriname in relation to the reference countries.

4.3.3 Index Concentration in Single ages for male and female population of main regions of Suriname

The Index Concentration in Single ages ending in "0" and "5" for the population of the main regions of Suriname in Census 2004 for male and female population is presented in FIGURE 4.3. As can be seen only for the age of 90 the preference for male population in the urban coastal area is high (***213.74***). For the female population of the urban coastal area some preference is for the age 80 and 85 (***119.97 and 108.18***) in comparison to other female ages in the same area. Overall there does not exist for all the three regions by sex some preference in the other ages this due, to the results of the values of ICSI close to 100 and thus within the range of values for countries with good data[40].

FIGURE 4. 3: Index concentration in single ages for Census population 2004 in the main regions of Suriname



Source: GBS Census data2004 of Suriname

The results of the Index Concentration in Single ages for ages ending in "0" and "5" for Census 2012 are presented in FIGURE 4.4. The results show clearly that the values of ICIS are for the young, adult ages and elderly are constant in Census 2012 and very close to 100.

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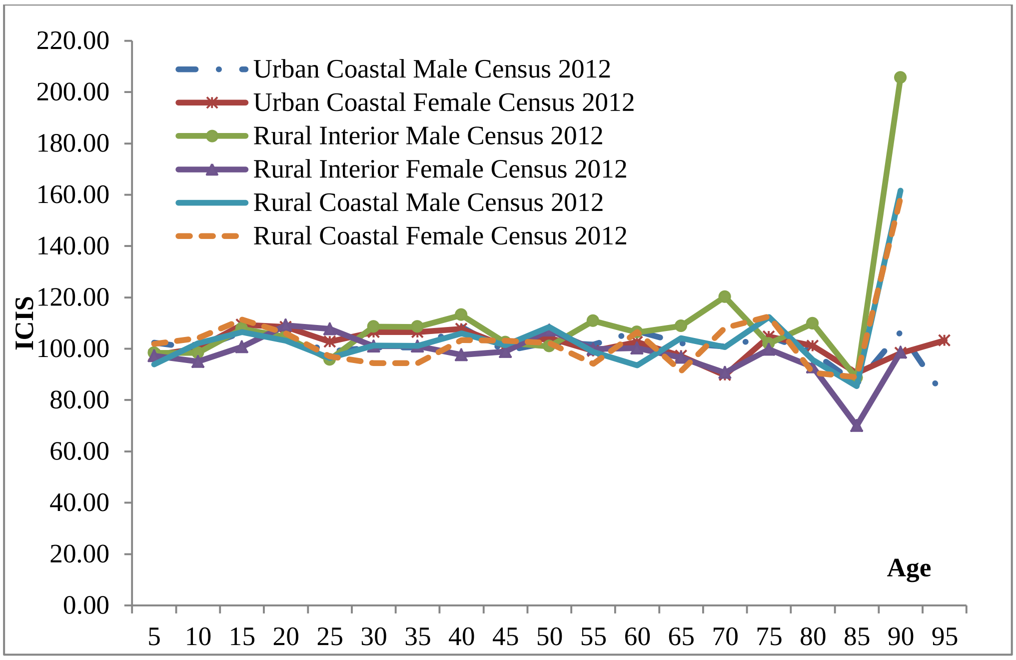
[40] According to data of the Human Mortality data base (2008) developed countries as the Netherlands, Italy, France, England and Switzerland had values of ICSI for population in 2000 between 78 and 127,8 for male population and for female population between 78.6 and 126.7 (Agostinho, 2009)

In the group of the eldest of the elderly the preference is in the age of 90 years for the male population in the rural interior and rural coastal area. For the female population the preference of 90 years is only in the rural coastal area. Remarkable is that among the male population in the rural interior area there is also a certain preference for age 70 followed by age 55.

The conclusion with respect to the quality of the population data in Census 2012 for the urban coastal area in Suriname is that it can be considered good for all the ages. However in the rural coastal area the data can be considered good for the young adult up to the elderly group. The group of the eldest of the elderly in the rural coastal area show some data problem. With respect to the rural interior area the data also show problems in the extreme old ages in Census 2012.

FIGURE 4. 4: Index concentration in single ages for Census population 2012 in the main regions in Suriname



Source: GBS Census data 2012 of Suriname

4.4 Evaluation data quality of the death counts data for main regions of Suriname

This paragraph presents the results of the Whipple´s Index, Coale and Kisker (1986) measure and the Index Concentration in single ages for the death count data of the main regions of Suriname for the period 2004-2012.

4.4.1 Whipple´s Index for death count data male and female for main regions of Suriname

Even as for Suriname also for the main regions of Suriname the death count data will be examined on its quality using the whipple index. TABLE 4.6 represent the values of Whipple Index for digit “0” and”5” for the areas urban coastal, rural Interior and rural Coastal area. Results show that in general, data is precise for the urban coastal and rural coastal area for male and for female population. It is remarkable that the Whipple´s Index for the urban coastal area and rural coastal area show better results for the male than for the female population.

For the rural interior area the results of the Whipple´s index for the female population are better than for the male population. It is important to stress that the average number of deaths for respectively the female and male population in the rural interior was about 131 and 168 deaths for the period 2009-2012. As seen before, the rural interior is an area with the smallest population density, whereby only 13.16% (71.268) of the population of Suriname live. It occurs that in some single years there are no yearly register of deaths in the rural interior area, due to the small population. The rural interior area (Sipaliwini, Brokopondo and Marowijne) is also characterized as to be an area with negative net migration for the young adult age groups. The rural interior area presents for the male population in the age group 23-77 and 58-77 acceptable data and for the age group 23-62 the data is less precise. The age groups 23-87, 23-97 and 78-97 present precise data for the male population (see TABLE 4.7). However for all the age groups the data of the female population in the rural interior area is precise.

TABLE 4. 6: Whipple´s Index for death count data of the urban coastal, rural interior and rural coastal area of Suriname 2006-2012 (both sexes) and 2009-2012 (female and male)

DEATHS	WHIPPLE INDEX	Urban	Coastal
	2009-2012	2009-2012	2006-2012
	DIGIT" 0" and "5"	DIGIT" 0" and "5"	DIGIT" 0" and "5"
Age	Female	Male	Both sexes
23-62	102	100	101
23-77	98	98	102
23-87	94	95	100
23-97	108	96	101
58-77	119	96	105
78-97	99	91	97
DEATHS	WHIPPLE INDEX	Rural	Interior
	2009-2012	2009-2012	2006-2012
	DIGIT" 0" and "5"	DIGIT" 0" and "5"	DIGIT" 0" and "5"
Age	Female	Male	Both sexes
23-62	86	108	94
23-77	76	120	99
23-87	82	102	96
23-97	86	103	96
58-77	84	115	96
78-97	91	89	101
DEATHS	WHIPPLE INDEX	Rural	Coastal
	2009-2012	2009-2012	2006-2012
	DIGIT" 0" and "5"	DIGIT" 0" and "5"	DIGIT" 0" and "5"
Age	Female	Male	Both sexes
23-62	102	90	97
23-77	102	94	100
23-87	82	93	95
23-97	98	96	97
58-77	100	101	101
78-97	96	97	93

Source: CBB death count data Suriname 2006-2012 (both sexes) and 2009-2012 (by sex)

4.4.2 Coale and Kisker (1986) measure for death count data for male and female of the main regions of Suriname

Application of the Coale and Kisker (1986) measure to the death count data also show that the quality of the data is reasonable. Considering the results of the female population within the main regions of Suriname we observe that for the rural interior area the highest values are for the age groups D100+/D80+ D95+/D70+, D80+/D60+, D90+/D60+ and D70+/D60+ .

However the Coale & Kisker measure applied to the main regions of Suriname for the female population presents results which are closer to the values of the reference countries Aruba followed by Curaçao for the period 2005-2010 (TABLE B2, ANNEX B).

TABLE 4. 7: Coale and Kisker (1986) measure for the average death count data 2004-2012 in the main regions of Suriname

			Urban Coastal			
	D100+/D80+	**D100+/D70+**	**D95+/D70**	**D80+/D60+**	**D90+/D60+**	**D70+/D60+**
Female	0.0146	**0.0078**	0.0407	0.4024	0.1001	0.7520
Male	0.0094	**0.0039**	0.0196	0.2805	0.0527	0.6797
			Rural Coastal			
	D100+/D80+	**D100+/D70+**	**D95+/D70**	**D80+/D60+**	**D90+/D60+**	**D70+/D60+**
Female	0.0157	**0.0157**	0.0220	0.3230	0.0600	0.7310
Male	0.0110	**0.0106**	0.0140	0.2714	0.0333	0.6938
			Rural Interior			
	D100+/D80+	**D100+/D70+**	**D95+/D70+**	**D80+/D60+**	**D90+/D60+**	**D70+/D60+**
Female	0.0183	**0.0101**	0.0510	0.4379	0.1081	0.7938
Male	0.0103	**0.0052**	0.0209	0.3784	0.0729	0.7432

Source: CBB death count data Suriname 2004-2012

It is importnant to observe that Jamaica and Suriname belongs to group ***II*** of the qualification of Luy(2010) based on the mortality data. The differences of results between this two countries for the different age groups is very small. For the male population only for some age groups (D95+/D70+, D80+/D60+, D90+/D60+ and D70+/D60+) the values of the rural interior area are higher than for the other regions. Even as for the male population the values for the main regions of Suriname are also between the values of Aruba and Curacao. But for the male population the values of the main regions of Suriname are not so close to that of Jamaica as seen for the female population. The values of the Netherlands (2005-2010) are also higher than the values of main regions of Suriname for the male population.

4.4.3 Index Concentration in Single ages for death count data for male and female of the main regions of Suriname

For the male and female popualtion the analyse of the ICSI is not estimated, because the number of deaths are on average very small in some age groups in the period 2009-2012. For the female population for example the application of ICSI on the death data of the main regions of Suriname results in zero values for some ages (5, 10 and 60 years) respectively, in the rural coastal, urban coastal and rural interior area. So, the quality of the death count data for female population in the main regions of Suriname based on ICSI can not be estimated. For the male population the figure of the appplication of ICSI is some what better than for the female population. The values for male death count data (2009-2012) for the main regions are also between 27.46 and 209.15 whereby the minimum value is far out of the range for countries with good data. Further more the ICSI curve for the rural interior area pressents for male and female population a lot of fluctuations, due to the small numbers of death. For the urban coastal area and rural coastal area the fluctutations are less visible.

Concluding we observe that just as in case of the population data of the main regions of Suriname the quality of the death data for the urban coastal and rural coastal araea of Suriname can also be considered good based on the results of the Whipple´s Index and the Coale & Kisker measure. With respect to the rural interior area the death data show possible problems at extreme old ages, based on the measures used in this paragraph. The ICSI does not provide the possibility of analyse of the preference of digit “0” and “5” for all the main regions by sex, due to the very small number of deaths or zero deaths in some ages. The availability of death count data of a longer period than 4 years should had made the analyse of ICSI possible.

5. PARAMETERS DEATH DISTRIBUITION METHODS AND DIAGNOSTIC PLOTS FOR SURINAME 2004-2012

This chapter presents the different Death Distribuition Methods (GGB, SEG, GGB-SEG) applied in order to estimate adult mortality for Suriname in the period 2004-2012. After the application of the DDMs different diagnostic plots will be presented with the objective to identify possible violation of the assumption of the methods applied.

5.1 Parameters Death Distribution methods for Suriname 2004-2012

The estimation of the coverage of the enumeration of deaths for the GGB, SEG and GGB-SEG method can be done for different age segments. The choice is made to present the results of the GGB, SEG and GGB-SEG based on different age segments. A special age segment is the age segment 5+ to 65+, because this age segment contains young childhood, and most adult experience (experience of migration) as was proposed by Hill, You and Choi (2009).

In order to analyse all the parameters of the GGB, SEG and GGB-SEG method TABLE 5.1 and TABLE 5.2 are presenting age segments ***including*** and ***excluding*** peak migration for respectively, the male and female population. The chosen age segments ***including*** high net migration are the age segments 5+ to 65+, 15+ to 55+ and 15+ to 75+. The age segments ***excluding*** high net migration are 30+ to 60+, 30+ to 65+, 30+ to 75+, 35+ to 65+ and 35+ to 75+. The choice of these age intervals is done in order to see the differences of the completeness of death register for the different lifecycles and the effect of the presence or absence of migration, beside the presences of other data errors related to age. Age intervals with lower limit 5 contain age groups of childhood and the age groups with upper limit 69 and 74 contains the elderly population. So the age groups combine in some cases childhood with adulthood (5 - 69), only adulthood (15 - 59) and part of adulthood with the elderly (35 - 69, 35 - 79, 30 - 64, 30 - 69 and 30 - 74).

The results presented for the GGB method are the values of the census coverage change from census 2 to census 1 $\left(\frac{k_1}{k_2}=\exp(At)\right)$ and the completeness of death registration relative to the population $\left(C=\frac{1}{K}\right)$. For the SEG and GGB – SEG the completeness of death registration $c(a)$ of Census 2012 relative, to census 2004 are presented.

Considering the result of the GGB method age segment 5+ to 65+ for male population in TABLE 5.1 there was due to the value of 1.0128 coverage of Census 2004 to 2012 of 1.28 %.

Moreover the average completeness of death recording for the same age segment was 36.35 % higher relative to the population. Furthermore, the death recording is 7.93 % higher than population recording for age segment 5 +to 65+ using the SEG method. So, it is clear that the different methods produce different results for the completeness of death registration relative to the population for one specific age segment. Each method is sensitive to determinate data errors and thus specific results express the possible presence of the specific data errors.

The results of the age segments ***excluding*** peak migration in TABLE 5.1 show that age segment 30+ to 75+ for male population applying SEG has the completeness of death registration relative to the population equal 1.0800 indicating that the inter censal death register is 8% higher in relation to the population of both census.

On the other hand, the SEG method presents for the completeness of death registration relative to the population for all age segment ***including*** high net migration lower results in comparison to the GGB method. The GGB and SEG method presents higher values for the completeness of death registration relative to population in comparison to the GGB-SEG method for age segments ***excluding*** high proportion of net migration. In other words, the GGB and SEG overestimate mortality, while the GGB-SEG presents under registration. Age segment 35+ to 75+ for example presents the unity for slope K using GGB method, however shows a result of under registration of deaths of 12.2% using the GGB-SEG method. The age segment 30+ to 65+ has the completeness of death registration relative to population of 1.1021 and 1.0068, using respectively the SEG and GGB-SEG method. As can be observe the three methods adopted provide different values for the completeness of death register for male population. There for it is important to stress that with respect to the completeness of death register relative to the population we observe:

- More variability of results of the different age segments within the GGB and GGB-SEG method
- The GGB method presents much higher values of C (***0.132 and 0.284***) for age segments ***including*** high proportion of net migration (15+ to 55+ and 5+ to 65+) in relation to the SEG method
- Less variability of the results for the different age segments within the SEG method

The change of census coverage using GGB show for all the age segments very small differences between all the age segments. For age segments ***excluding*** high proportion of net migration the census coverage change are less than the unity. With respect to the intercept of the GGB method we notice that all the age segments excluding high proportion of peak migration presents improvement of the coverage of census 2012 in relation to census 2004. Age segment 35+ to 75+ show the best result ***(-0.0051***)

TABLE 5. 1: Completeness of death recording relative to male population (GGB, SEG and GGB-SEG method) and Census coverage change: Census 2012 to Census 2004 (GGB method)

GGB method			**SEG method**	**GGB-SEG method**
			Completeness of death registration relative to population	
Age segments <u>Including</u> High net migration	**Census coverage change: 2012 to census 2004**	**Completeness of death registration relative to population (1/K)=C**	unadjusted for census coverage change	adjusted for census coverage change (***according To age segment***)
15+ to 55+	1.0220	1.2139	1.0824	1.2137
5+ to 65+	1.0128	1.3635	1.0793	1.1571
15+ to 75+	0.9861	1.0484	1.0658	1.0068
			Completeness of death registration relative to population	
Age segments <u>Excluding</u> High net migration	**Census coverage change: 2012 to census 2004**	**Completeness of death registration relative to population (1/K)=C**	unadjusted for census coverage change	adjusted for census coverage change (***according to age segment***)
30+ to 65+	0.9861	1.1064	1.1021	1.0068
30+ to 75+	0.9666	1.0073	1.0800	0.9089
35+ to 75+	0.9600	0.9943	1.0776	0.8780
30+ to 60+	0.9740	1.2008	1.1113	0.9449
35+ to 65+	0.9801	1.0855	1.1022	0.9758

Source: Data GBS and CBB.

In TABLE 5.2 we observe that for the age segment 15+ to 75 census coverage changes from census 2012 to census 2004 has an increase of 1.58 %. The completeness of death recording relative to the population applying GGB reveal for all the age segments values higher than the unity in case of the female population. Possible explanation may be due to the effect of emigration, census coverage, age varying of death register and age varying of the living within the inter censal period. Comparing the results of completeness of death recording for female population between the SEG and GGB method, we observe that there small differences for the age segments ***excluding*** high proportion of migration. On the other hand, for the age segments ***including*** high proportion of migration the values of C are somewhat higher than for the age segments ***excluding*** high proportion of migration, using GGB method.

TABLE 5. 2: Completeness of death recording relative to female population (GGB, SEG and GGB-SEG method) and Census coverage: change Census 2012 to Census 2004 (GGB method)

GGB method			**SEG method**	**GGB-SEG method**
			Completeness of death registration relative to population	
Age segments <u>Including</u> High net migration	**Census coverage change: 2012 to census 2004**	**Completeness of death registration relative to population (1/K)=C**	unadjusted for census coverage change	adjusted for census coverage change (***according to age segment***)
15+ to 55+	0.9937	1.1821	1.0981	1.0585
5+ to 65+	0.9964	1.1747	1.0813	1.0752
15+ to 75+	0.9842	1.0892	1.0783	1.0585
			Completeness of death registration relative to population	
Age segments <u>Excluding</u> High net migration	**Census coverage change: 2012 to census 2004**	**Completeness of death registration relative to population (1/K)=C**	Unadjusted for census coverage change	adjusted for census coverage change (***according to age segment***)
30+ to 65+	0.9808	1.0966	1.0929	0.9800
30+ to 75+	0.9756	1.0649	1.0764	0.9532
35+ to 75+	0.9712	1.0504	1.0722	0.9283
30+ to 60+	0.9817	1.1043	1.1000	0.9874
35+ to 65+	0.9775	1.0822	1.0899	0.9638

Source: Data GBS and CBB

Analysing the GGB-SEG method in relation to the SEG method for female population we notice that for all the age segments ***including*** high proportion of net migration the GGB-SEG over estimate mortality less. The SEG presents over registration of death counts for age segments ***excluding*** high proportion of net migration, while GGB-SEG reveals under registration of death. The results of GGB-SEG are of small <u>***not***</u> completeness of death recording (between *0.00126* and *0.00717*) for female population considering the age segments 30+ to 65+, 30+ to 75+, 30+ to 60+, 35+ to 65+ and 35+ to 75+. Important to observe is that for male and female population, the differences of the results of completeness of death recording are small between age segments applying the SEG method, thus presenting less variability.

The GGB-SEG method overestimates mortality less for female population in relation to the male population for the age segments ***including*** and ***excluding*** age groups with high proportion of peak migration. For age segment 30+ to 60+ the SEG method overestimate mortality 10% higher than population recording for female population, while for the same age segment the GGB-SEG presents under registration of mortality 0.00126. This overestimation for the age segment 30+ to 60+ may be related to International immigration of mature adults and adults at older ages besides the consideration of eventually return migration.

Concluding, the results of the GGB and GGB-SEG method for female and male population provide better results for age segment starting at 30+ or 35+. In other words, age groups ***excluding*** high proportion of peak migration should be preferable in the estimation of adult mortality.

It is also a fact that the coverage of the enumeration for the male population from 2004-2012 in Suriname for the age segments 15+ to 55+ and 5+ to 65+ (TABLE 5.1) are more than the unity (1.0220 and 1.0128) and higher than for the female population. This means that coverage of the census 2004 for the male population was higher than in Census 2012 for these age segments. For the female population of Suriname for age segment 5+ to 65+ and 15+ to 55+ the coverage of 2012 was better than in 2004 (TABLE 5.2).

5.2 Diagnostic plots of the Death ditribuition methods for Suriname by sex, 2004-2012

Primary in this paragraph the GGB plots for Suriname 2004-2012 of the male and female population are presented and analysed. In the second place also for male and female population the SEG plots and the GGB-SEG plots by age segments ***including*** or ***excluding*** high proportion of peak migration are presented and discussed for Suriname 2004-2012.

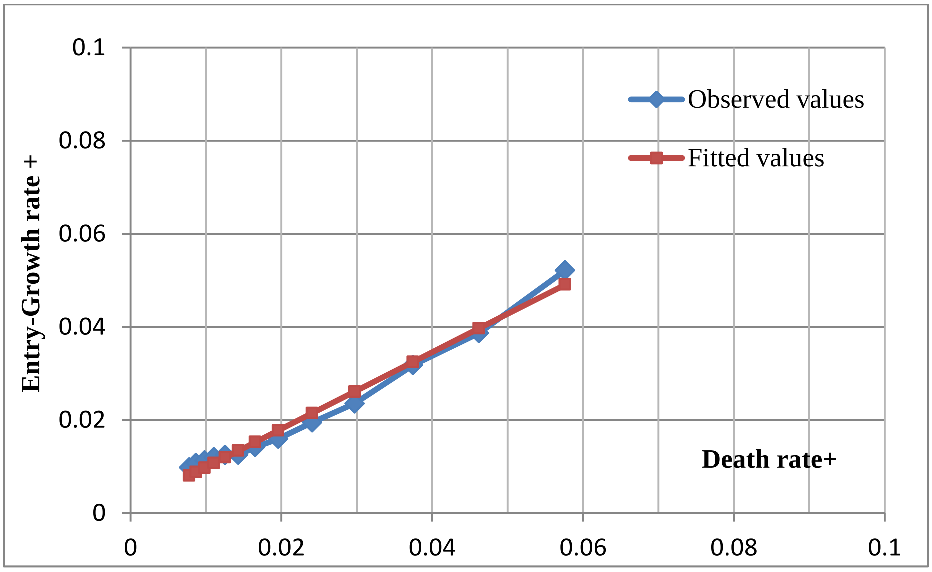
5.2.1 Diagnostic plots of the GGB method for male and female population 2004-2012

According to Hill, Choi and Timaeus (2005) plots of GGB method indicate that adjusted for census coverage changes completeness of death recording is comparable across age segments for both periods. In the case of this study it is for census 2004 and census 2012. The diagnostic plots using the GGB method can be presented using the age ranges 15+ to 55+, 5+ to 65+ (age segments with high proportion of migration) and 30+ to 65+ (age segments without high proportion of migration). Hill, You and Choi (2009) have proposed to test the age ranges 15+ to 55+ and 5+ to 65+. According to Hill, You and Choi (2009) it is good when applying both GGB and SEG to fit to the age range 30+ to 65+ in populations affected by migration. The test of 15+ to 55+ is done because it approximates the age range of the main summary index of mortality, the probability of dying between the ages of 15 and 60 ($_{45}q_{15}$). The choice in this dissertation is done for the age range 5+ to 65+ because it covers childhood and most adult experience.

The diagnostic plots of the GGB method presented here for age segment 5+ to 65+, for male and female population produce similar results in the case of Suriname. In the young age groups the results demonstrate probably age misreporting, varying report of age at death and population or migration effects. For the age groups 45 -54 the observed value are below the fitted values for male and female population, indicating over registration of death which is probably due to migration. For male population age group 65+ presents small under registration of death probably due to exaggeration of age in the extreme old ages.

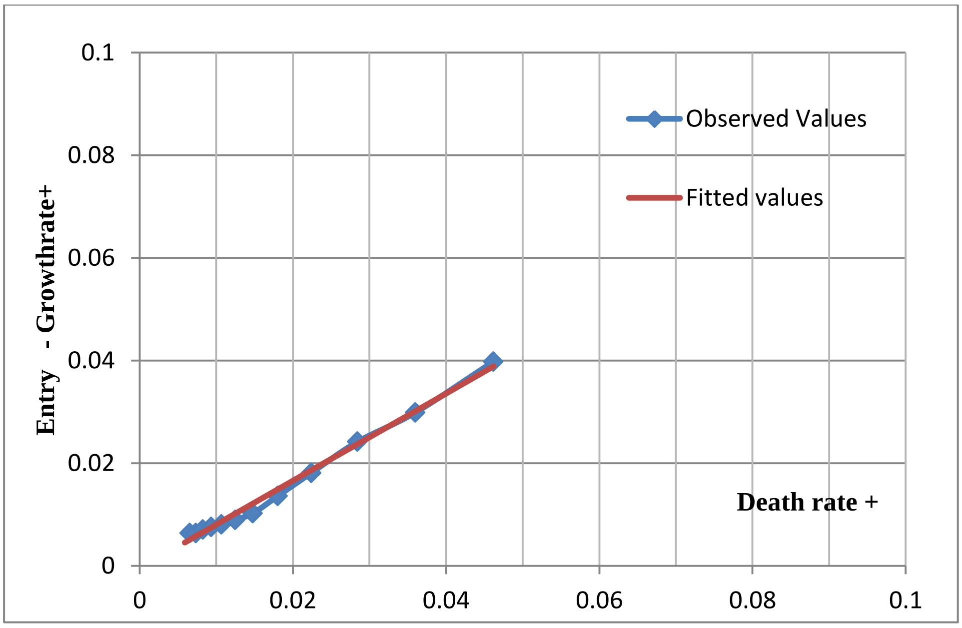
Moreover, the results of the diagnostic plots of the GGB method, age segment 5+ to 65+ for male and female population can also be considered good due to the fact that the population and death count data for Suriname are of good quality. However, part of the curve in FIGURE 5.1 and FIGURE 5.2 where the goodness of fit is less, a possible explanation that can be given is the migration pattern of the population and probably age varying coverage of population and death data.

FIGURE 5. 1: Observed versus fitted values mortality rates male population of Suriname, 2004-2012 (GGB method age segment 5+ to 65+)



Source : Data CBB and GBS

FIGURE 5. 2: Observed versus fitted values mortality rates female population Suriname 2004-2012 (GGB method age segment 5+ to 65+)



Source : Data CBB and GBS

5.2.2 Diagnostic plots of the SEG and GGB-SEG method for male and female population 2004-2012.

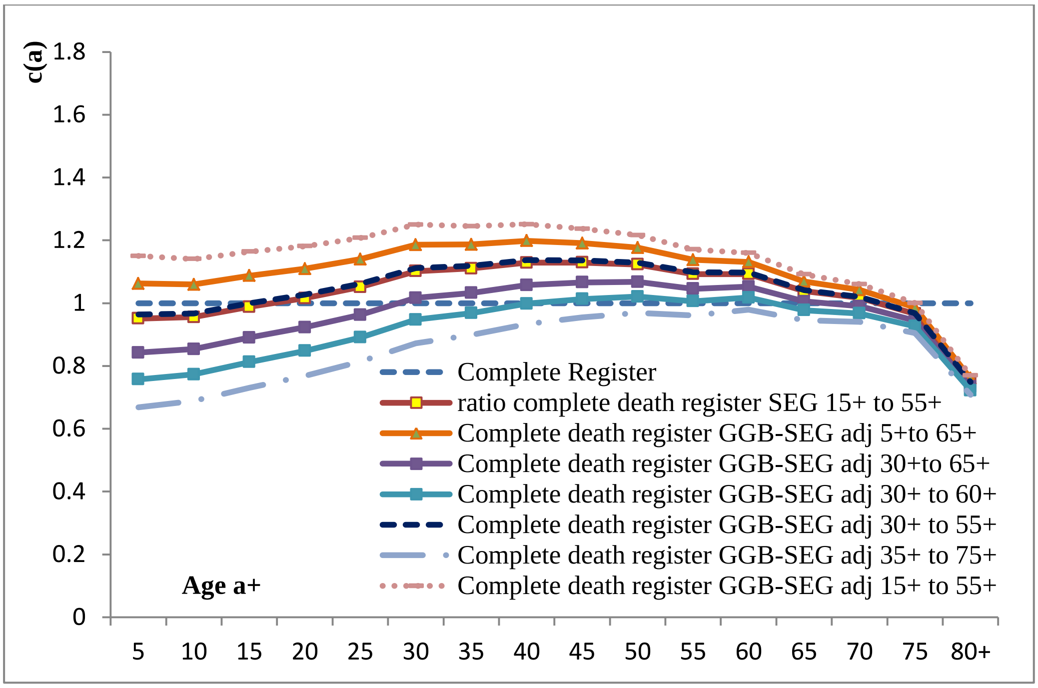
Hill and Choi (2004) observe that the diagnostic plots of the SEG method give clearer warnings of data problems in comparison to the GGB plots. The authors also mention that the combined approach GGB-SEG is less sensitive to age misreporting than the GGB but it is much better performance than SEG with change in census coverage or migration. In order to observe the differences in results of the SEG and GGB-SEG method the choice is made to present the diagnostic plots of the SEG method and the GGB-SEG method by different age segments in one FIGURE. The SEG method as observe before is sensitive to migration.

The choice is made to apply the GGB-SEG method by adjusting the census of 2004 with the factor of completeness of census 2004 to 2012 by the age segments 5+ to 65+ and 15+ to 55+ (age groups with high proportion of migration) and by age segments 30+ to 60+, 30+ to 65+, 35+ to 75+ and age segment 30+ to 55+ (age groups without high proportion of migration) of the GGB method. The SEG method presented is for age segment 15+ to 55+.

We observe that the SEG method for the male population overestimate mortality for age groups above 20 years until age groups of 60 years and over. The values of completeness of death reporting (a+) for the male population are increasing with age applying the GGB-SEG method adjusted by the age segment 30+ to 65+, 30+ to 55+, 35+ to 75+ and by 30+ to 60+ (FIGURE 5.3). The result of the SEG method and GGB-SEG adjusted by age segment 30+ to 55+ for male population are nearly similar. GGB-SEG adjusted by 15+ to 55+ presents for the male population of Suriname the highest levels of completeness of death recording relative to the population and over estimates mortality more than the SEG method

The GGB-SEG method adjusted by age segment 30+ to 60+ results in completeness of death register for 40 years and over up to 60 years and over. For age group 15 and over up to age group 40 and over the underreporting of death is about 80% and it increase to 100% (application GGB-SEG adjusted by 30+ to 60+). The under reporting of death is probably related to high proportion of peak international migration in the age groups 15-35.

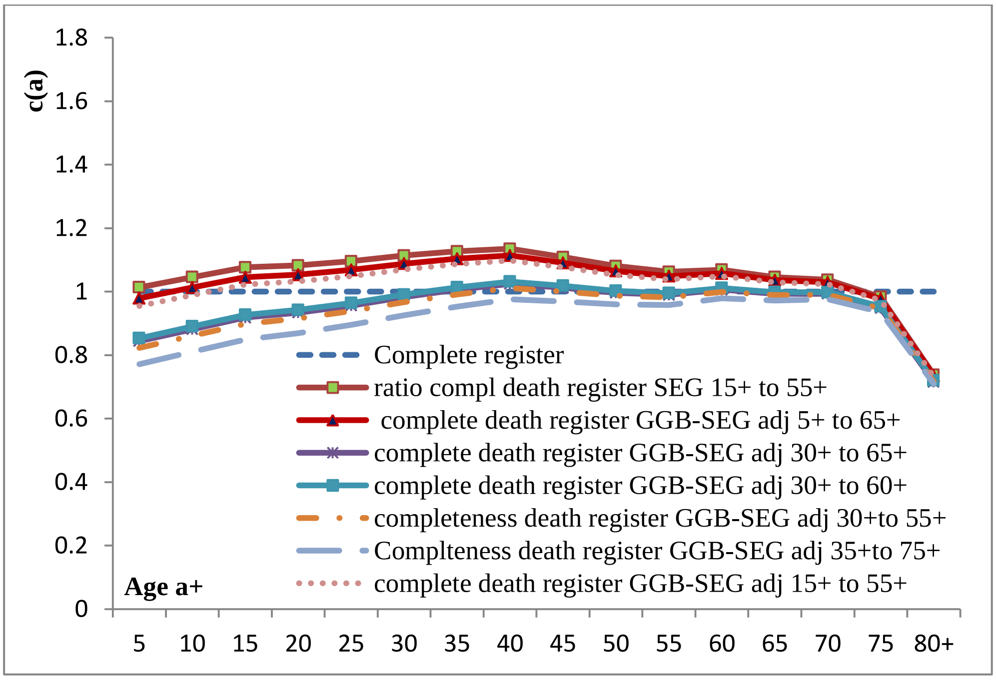
FIGURE 5. 3: Completeness of death reporting (a+) male population Suriname 2004-2012, SEG (15+ to 55+) and GGB-SEG method for selected age segments



Source : Data CBB and GBS

Considering the results of the SEG and GGB-SEG method for the female population of Suriname (FIGURE 5.4) we notice that the diagnostic plots are also not horizontal and overestimate death coverage using SEG method and GGB-SEG adjusted by age segment 5+ to 65+, 15+ to 55+ and 35+ to 75+. The over estimation of death coverage using SEG method for female population occurs for age groups 5 and over up to 70 and over and it may be related to migration characteristics of the country. For age groups 5 - 14 and 75+ there is completeness of death recording using GGB-SEG method adjusted by age segment 5+ to 65+. Using the GGB-SEG method adjusted by age segment 30+ to 60+, 30+ to 65 and 30+ to 55+ the pattern of rising estimates of completeness with age can be observed. The GGB-SEG method adjusted by age segments 30+ to 60+, 30+ to 65+ and 30+ to 55+ show nearly the same results and the best results for the female population of the country. We notice that for these three GGB-SEG plots for the age 35 and over up to age 70 and over the completeness of death recording is very close to the unity. From 5 years and over up to 30 there occur under register of death between 4% and 17% for the GGB-SEG plots with nearly the same results. Remarkable is that the level of under registration for male population in Suriname is higher than for female population at younger ages using the GGB-SEG adjusted by 30+ to 65+, 30+ to 55+, 35+ to 75+ and 30+ to 60+. A probable explanation that may be given is more male migration in the younger ages in combination with high mortality in these ages.

FIGURE 5. 4: Completeness of death reporting (a+) female population Suriname 2004-2012, SEG (15+ to 55+) and GGB-SEG method for selected age segments



Source : Data CBB and GBS

Concluding the results for female population for GGB-SEG adjusted by age segment 30+ to 55+ and 30+ to 60+ are very close to each other. However, for the male population GGB-SEG adjusted by age segment 30+ to 55+ produces better results in relation to GGB-SEG adjusted by 30+ to 60+ for the age groups below 30 years. For the ages between 30 and 60 years GGB-SEG adjusted by 30+ to 55+ over estimate completeness of death register, while

GGB-SEG adjusted by 30+ to 60+ under estimate completeness of death register from 30 over up to 40 over. Completeness of death recording relative to the population for male population is observed for 45 over up to 60 over by GGB-SEG adjusted by age segment 30+ to 60+. Even as for male population also for female population underreporting of death counts applying GGB-SEG adjusted by age segment 35+ to 75+ is notable for all the ages. However the levels of $c(a)$ for male population are higher than for female population.

Furthermore, the GGB-SEG and SEG for male and female population does the identification of the presences of the violations of the assumption of the method applied. However, it is not possible to quantify the presence of the errors. For sure, the no migration assumption is violated besides the age varying of the census and death coverage. The results of the GGB-SEG and SEG method for male and female population do not present strong varying in census coverage because the curves presents some degree of constancy.

6. PARAMETERS DEATH DISTRBUITION METHODS AND DIAGNOSTIC PLOTS FOR MAIN REGIONS OF SURINAME 2004-2012

This chapter presents the parameters applying the GGB method, SEG method and GGB-SEG method by different age segments for the urban coastal area, rural coastal area and the rural interior area of Suriname for the period 2004-2012 and for male and female population.

6.1 Parameters DDMS by sex for main regions of Suriname 2004-2012

The analyse of the parameters of the GGB and the SEG method will be done together considering firstly age segments ***with*** high proportion of migration and secondly age segments ***withou***t high proportion of migration. Furthermore the parameters are presented by sex and central regions. TABLE ***6.1*** and TABLE ***6.3*** show the parameters by GGB and SEG method for age segments *with high proportion* of migration for respectively male and female population for the main regions of Suriname. On the other hand TABLE ***6.2*** and TABLE ***6.4*** show the parameters by GGB and SEG method for age segments *without high proportion* of migration for respectively male and female population for the main regions of Suriname.

6.1.1 Parameters main regions for male population

Considering TABLE ***6.1*** which regards the male population of the central regions of Suriname, the census coverage change was in 2004 for age segment 15+ to 55+ in urban coastal area 3.24 % higher than for 2012. On the other hand, the completeness of death recording relative to the population for age segment 15+ to 55+ using GGB method was 50% higher relative to the population in the urban coastal area. Remarkable, is that the completeness of death registration relative to the population for all the selected age segments in TABLE ***6.1*** presents for the urban coastal area values higher than 100%. A possible explanation may be related to in migration to this area.

Considering the rural coastal area, age segment 5+ to 65+ presents the coverage change of census 2012 was 4.8% higher than for census 2004 in the rural coastal area. Furthermore, death recording for the same age segment was 2.8% lower than for the population using GGB method. The rural interior area reveals that for age segment 5+ to 65+ the completeness of death registration was 42.52% higher relative to the population in case of the application of the GGB method. A possible explanation may be due to out- migration from the rural interior area.

TABLE 6. 1: Completeness of death recording relative to male population (GGB, SEG and GGB-SEG method) and Census coverage change: Census 2012 to Census 2004 (GGB method) for age segments with high proportion of peak migration

MALE POPULATION CENTRAL REGIONS SURINAME				
GGB method			**SEG method**	**GGB-SEG method**
			Completeness of death registration relative to population	
Age segments including High net Migration	**Census coverage change: Census 2012 to Census 2004**	**Completeness of death registration relative to population (1/K)=C**	unadjusted for census coverage	Adjusted for census coverage change **(according to age segment)**
Urban Coastal			**Urban Coastal**	
15+ to 55+	1.0324	1.5002	1.1193	1.3642
5+ to 65+	1.0179	1.2965	1.1066	1.2279
15+ to 75+	0.9970	1.1438	1.1126	1.1328
Rural Coastal			**Rural Coastal**	
15+ to 55+	0.9582	1.0572	1.2308	1.0335
5+ to 65+	0.9524	0.9724	1.2029	0.9551
15+ to 75+	0.9318	0.8895	1.1570	0.8939
Rural Interior			**Rural Interior**	
15+ to 55+	1.0841	1.3664	0.7709	1.1001
5+ to 65+	1.1006	1.4252	0.7439	1.3085
15+ to 75+	1.0334	0.9326	0.8008	0.8498

Source : Data CBB and GBS

The results for the male population with respect to SEG method presents for all the age segments with high proportion of migration for the urban coastal and rural coastal area the result of over registration (TABLE ***6.1***). This is probably due to positive and negative net internal migration (FIGURE B.1 and B.2, ANNEX B) and international migration. However, the rural coastal area presents more over- register of death counts than the urban coastal area.

Using the SEG method, the rural interior area presents for the male population under reporting of death for all the age segments ***with*** and ***without*** age groups of peak migration (TABLE ***6.1 and 6.2***) which can be explained by emigration and age variability of death register and living in the rural interior area. The GGB-SEG method adjusted by age segment 5+ to 65+ show results of over-register of death counts for the urban coastal and the rural interior area for male population. The results for the urban coastal area are lower than for the rural interior area. An explanation for this pattern is that due to the adjustment of the census data of 2004 in the rural interior area, the effect of emigration on the small population increased. The rural coastal area presents for the male population in TABLE ***6.1*** undercounting of death using GGB-SEG method adjusted by age segment 5+ to 65+, this probably as a result of relatively less outmigration in relation to the rural interior area. As observed by Hill and Choi (2004) the GGB-SEG method has a somewhat lower sensitivity to age misreporting than GGB and it much better perform than SEG with change in census coverage or migration.

Considering the application of the GGB method for the male population with age segments ***without*** high proportion of migration (TABLE ***6.2***) we notice that age segment 30+ to 65+ for the urban coastal area and rural interior area presents completeness of death registration relative to the population of respectively 18.76% and 27.12%. This result indicates a difference of 8.36% between the urban coastal and rural interior area and thus reveals the violation of the method in the different regions by sex for the same age segment. Furthermore, only in the rural interior area applying the GGB method for age segments 30+ to 60+, 30+ to 65+, 35+ to 65+, 35+ to 75+ and 30+ to 75+ the coverage of census 2004 to 2012 declined due to, values above unity (TABLE ***6.2***).

Analysing the SEG method in TABLE ***6.2***, we observe for the rural interior area that for all age segments underestimate of death coverage relative to the population happens. Remarkable is that in the rural interior area for male population underestimate of death coverage is higher for age segments with peak migration compared to age segments without peak migration applying the SEG method. Once again out-migration of male impacts a lot on the tiny scale of the population in the rural interior area.

Census coverage change from 2012 to 2004 is for all the age segments of the urban and rural coastal area is between 0.006% and 8.52 % (census coverage of 2012 was better than 2004), using GGB. Considering the rural interior area (TABLE ***6.2)*** we observe that for age segments 30+ to 65+ and 30+ to 75+ the census coverage of 2012 to 2004 was 4.88% and 1.00% (census coverage 2004 was better than 2012). Completeness of death registration relative to population using GGB method was for age segment 30+ to 60+ of the urban coastal area and the rural interior area respectively 31.05% and 37.53% (over estimation). The GGB-SEG method adjusted by age segment 30+ to 65+ of GGB presents for urban coastal area and rural interior area over estimate of death coverage, while for the rural coastal area under estimate of death coverage is observed (TABLE ***6.2***).

The result of the completeness of death recording relative to the population applying SEG method for urban coastal area may be due to international emigration and for the rural interior area it is due to out-migration. Moreover, the possibility of more age misreporting for the census and age varying of death register and the small scale of the population in the rural interior area may cause the difference in results with the urban and rural coastal area.

TABLE 6. 2: Completeness of death recording relative to male population (GGB, SEG and GGB-SEG method) and Census coverage change: Census 2012 to Census 2004 (GGB method) for age segments without peak migration

MALE REGIONS SURINAME				
GGB method			**SEG method**	**GGB-SEG method**
			Completeness of death registration relative to population	
Age segments <u>Excluding</u> High net Migration	**Census coverage change: Census 2012 to census 2004**	**Completeness of death registration relative to population (1/K) = C**	unadjusted for census coverage change	adjusted for census coverage change **(*according to age segment*)**
Urban Coastal			**Urban Coastal**	
30+ to 65+	0.9934	1.1876	1.1614	1.0833
30+ to 75+	0.9770	1.0956	1.1358	1.0194
35+ to 75+	0.9684	1.0786	1.1377	0.9796
30+ to 60+	1.0088	1.3105	1.1609	1.2053
35+ to 65+	0.9847	1.1543	1.1581	1.0618
Rural Coastal			**Rural Coastal**	
30+ to 65+	0.9284	0.9079	1.1614	0.8725
30+ to 75+	0.9174	0.8674	1.1198	0.8269
35+ to 75+	0.9148	0.8636	1.0969	0.8154
30+ to 60+	0.9379	0.9561	1.1846	0.9245
35+ to 65+	0.9272	0.9050	1.1379	0.8719
Rural Interior			**Rural Interior**	
30+ to 65+	1.0488	1.2712	0.8480	1.0008
30+ to 75+	1.0100	0.8884	0.8402	0.7541
35+ to 75+	1.0009	0.8722	0.8492	0.7198
30+ to 60+	1.0821	1.3753	0.8380	1.0889
35+ t0 65+	1.0743	1.2796	0.8607	1.0466

Source : Data CBB and GBS

6.1.2 Parameters main regions for female population

Analysing the results of the parameters of the female population for age segments ***including*** high proportion of migration (TABLE ***6.3***) we observe that with respect to the GGB method, the urban coastal area presents completeness of death registration relative to the population greater than the unity for all the age segments. Hereby age segments 15+ to 55+ has the highest value namely of 29.12 %. The explanation of high value in age segment 15+ to 55+ can be explained by the intense migration in this group (FIGURE B1 in ANNEX B). Age segment 15+ to 75+ has the lowest completeness of death register relative to the population (21.90%) in the urban coastal area and the explanation is that the effect of migration in the younger age groups is cancelled out by probably return migration in the older ones, besides the higher mortality at older ages.

TABLE 6. 3: Completeness of death recording relative to female population (GGB, SEG and GGB-SEG method) and Census coverage change: Census 2012 to Census 2004 (GGB method) for age segments with high proportion of peak migration

FEMALE POPULATION CENTRAL REGIONS SURINAME				
GGB method			**SEG method**	**GGB-SEG method**
			Completeness of death registration relative to population	
Age segments <u>Including</u> High net Migration	**Census coverage change: Census 2012 to census 2004**	**Completeness of death registration relative to population (1/K)=C**	unadjusted for census coverage change	adjusted for census coverage change (***according to age segment***)
Urban Coastal			**Urban Coastal**	
15+ to 55+	0.9962	1.2912	1.2040	1.0581
5+ to 65+	0.9958	1.2889	1.2042	1.2375
15+ to 75+	0.9890	1.2190	1.1900	1.0153
Rural Coastal			**Rural Coastal**	
15+ to 55+	0.9518	0.8846	1.1256	0.8740
5+ to 65+	0.9599	0.9119	1.1080	1.0064
15+ to 75+	0.9495	0.8766	1.0763	0.8626
Rural Interior			**Rural Interior**	
15+ to 55+	1.0350	1.1599	0.7793	0.8135
5+ to 65+	1.0425	1.0137	0.7254	1.0043
15+ to 75+	1.0062	0.8502	0.7778	0.6938

Source : Data CBB and GBS

However, the rural coastal area presents for all the age groups using GGB method (TABLE ***6.3***) completeness of death register relative to the population below the unity, which is based on the migration pattern in this area. As FIGURE B.2 in ANNEX B shows some age groups present high levels of out migration and others also show relatively high levels of in migration. In the rural interior area age segment 15+ to 55+ has lower under register (13.78%) in relation to the urban coastal area (22.54%). Explanation of lower completeness of death reporting relative to the population in the rural interior area in relation to the urban coastal area for age segment 15+ to 55+ can be given by the less migration effect for female population in the rural interior area (TABLE ***6.3***).

TABLE 6. 4: Completeness of death recording relative to female population (GGB, SEG and GGB-SEG method) and Census coverage change: Census 2012 to Census 2004 (GGB method) for age segments without high proportion of peak migration

FEMALE POPULATION SURINAME				
GGB method			**SEG method**	**GGB-SEG method**
			Completeness of death registration relative to population	
Age segments <u>Excluding</u> High net Migration	**Census coverage change: Census 2012 to Census 2004**	**Completeness of death registration relative to population (1/K)=C**	unadjusted for census coverage change	adjusted for census coverage change (***according to age segment)***
Urban Coastal			**Urban Coastal**	
30+ to 65+	0.9917	1.2652	1.1201	1.1504
30+ to 75+	0.9833	1.1997	1.1875	0.9822
35+ to 75+	0.9796	1.1879	1.1871	0.9617
30+ to 60+	0.9928	1.2774	1.2050	1.0374
35+ to 65+	0.9878	1.2438	1.2024	1.0084
Rural Coastal			**Rural Coastal**	
30+ to 65+	0.9407	0.8570	1.0726	0.8004
30+ to 75+	0.9404	0.8605	1.0478	0.8179
35+ to 75+	0.9411	0.8617	1.0292	0.8213
30+ to 60+	0.9350	0.8283	1.0860	0.7923
35+ to 65+	0.9423	0.8611	1.0522	0.8267
Rural Interior			**Rural Interior**	
30+ to 65+	0.9808	0.8011	0.8151	0.6967
30+ to 75+	0.9807	0.7969	0.8033	0.6020
35+ to 75+	0.9758	0.7871	0.8028	0.5858
30+ to 60+	0.9941	0.8884	0.8266	0.6486
35+ to 65+	0.9715	0.7718	0.8199	0.5719

Source : Data CBB and GBS

Just like for the male population of the rural interior the female population of this area also is characterized by under estimation of mortality, between 22.59% and 27.78%, using the SEG method for the age segments ***including*** peak migration (TABLE ***6.3).***The application of the GGB method for age segments ***without*** age groups of peak migration produces for age segment 30+ to 60+ of the urban coastal area, female population the highest completeness of death register relative to the population, namely of 27.74%. We may observe that the application of the GGB method for age segments ***with*** age groups of high peak migration produces also completeness of death register above the unity just like for age groups ***without*** high proportion of peak migration (urban coastal area female). Remarkable is that the values of C for age segments ***without*** high proportion of peak migration are higher than those ***with*** high proportion of peak migration**.** The plausible explanation is that the lower migration in the age segments starting in ages 30+ or 35 + the results of C suffers less of the migration effect. Moreover, age varying of the death and living, age misreporting of the population (Census data) in the age groups starting with 30+ or 35+ might be smaller compared to age segments starting in 5+ or 15+. The coverage of census 2012 in relation to census 2004 is also better for ages starting at 30+ or 35+, compared to ages starting at 5+ or 15+ for female population of the urban coastal area.

Furthermore, for all age segments in the rural coastal and rural interior area we notice completeness of death reporting relative to the population below the unity using the GGB method (TABLE ***6.4***). This result in the case of the application of the GGB method for age segments ***without*** age groups of high peak migration for the rural coastal and rural interior area is explained by the absence of less migration and probably age misreporting at older ages of Census data. The Combined approach GGB-SEG shows for female population of the rural coastal and rural interior area for age segments ***excluding*** high proportion of migration that the completeness of death registration relative to the population are all below the unity. For the rural coastal area and the rural interior area the under-recording of death thus underestimating of mortality vary between ***0.173*** **and** ***0.208*** and ***0.303 and 0.428,*** respectively. The high under-reporting of death for female population in the rural interior area, using GGB-SEG (adjusted for census coverage) may be explained by less migration of the female population in the age segments starting in 30+ or 35+, besides age varying coverage of census and deaths. Age varying coverage of death may occur in the rural interior area more than in the rural coastal area due to, the small scale of yearly register of deaths. As seen before applying GGB-SEG (adjusted for census coverage) for male population in the rural interior area for age segments starting in 30+ or 35+ results in over register between ***0.001 and 0.009*** and under register between ***0.246 and 0.280*** which, is less than in case for female population in the rural interior area.

6.2 Diagnostic plots of the Death Distribution methods for the main regions of Suriname by sex, 2004-2012

In this paragraph the diagnostic plots of the methods GGB, SEG, GGB – SEG for some selected age segments, for male and female population of the urban coastal, rural coastal and rural interior area of Suriname will be presented. Analyse of the plots is done according to the study of the sensitive analysis with simulated data errors applying the GGB, SEG and GGB-SEG method (Hill and Choi (2004)).

6.2.1 Diagnostic plots for the GGB method for male and female population for the main regions of Suriname 2004-2012

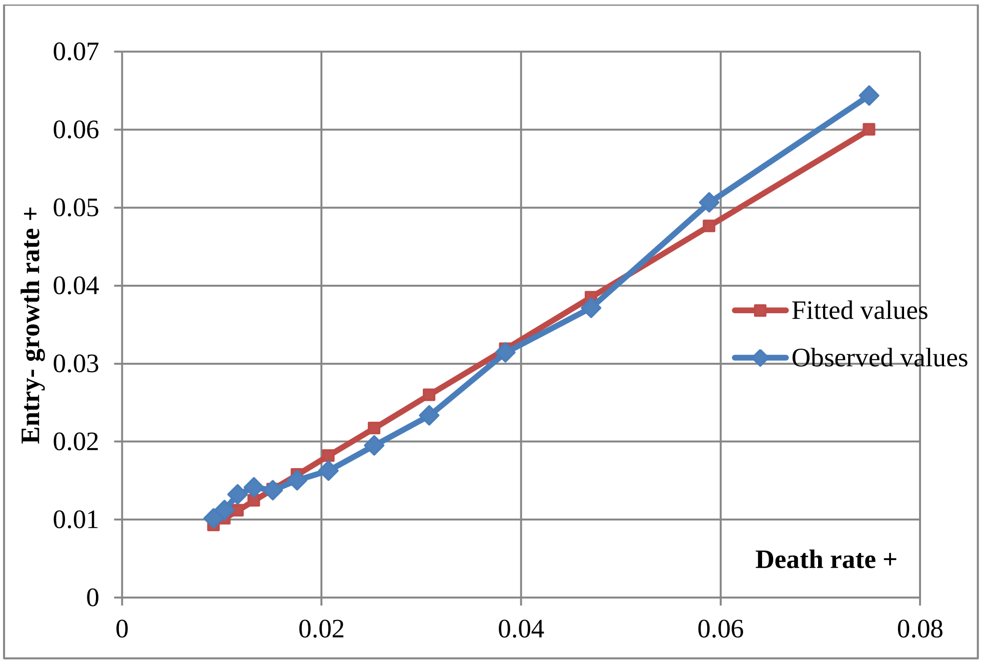
The diagnostic plots using the GGB method, age segment 5+ to 65+ for the central regions of Suriname are presented in this paragraph for male and female population.

6.2.1.1 Urban coastal area GGB plots age segments 5+ to 65+

The analyse of the GGB diagnostic plots for the male population in the urban coastal area show that the GGB plot based on age segment 5+ to 65+ presents over registration of death in the age group 15-19, 20-24, 60-64 and 65+ and thus no goodness of fit (FIGURE 6.1). In the young adult age groups no goodness of fit is due to the presence of emigration and age varying of census coverage. In the older age groups no goodness of fit is probably due to eventually return migration and overstatement of age at older ages. For the ages 30 up to 59 the situation of under registration of death is notable as a result of immigration. It is good to remember that the data quality in the evaluation of death and population data was considered to be good for the urban coastal area.

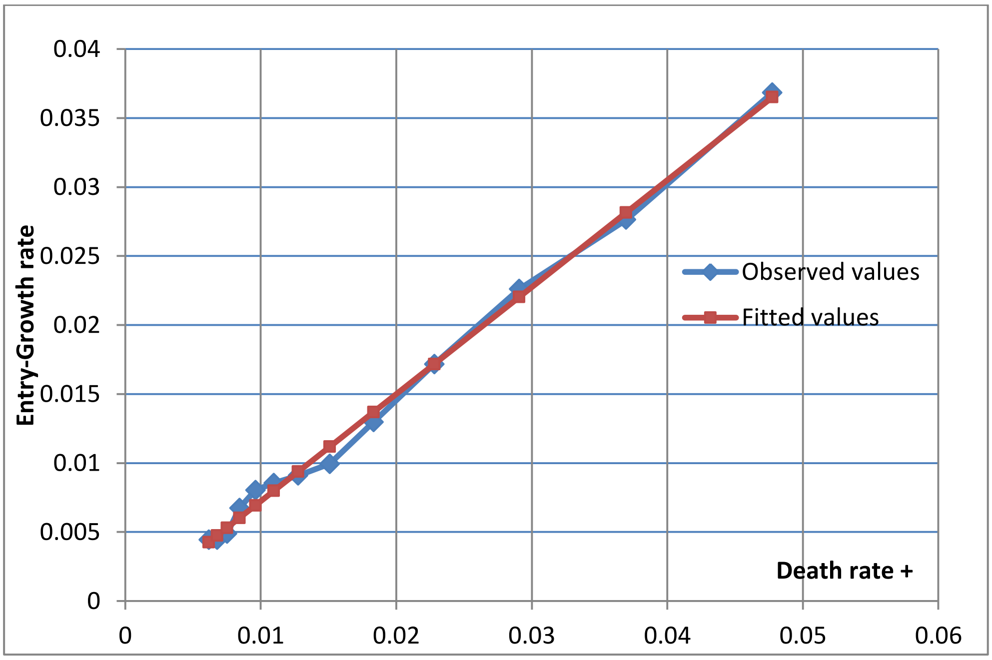
The GGB diagnostic plot for the female population of the urban coastal area (FIGURE 6.2) show for the age segments 5+ to 65+, better goodness of fit in relation to the GGB plot for male population. This means that the GGB method reveal probable less problems related to the assumption of no migration for the female population of the urban coastal area in comparison to the male population of the same area. Furthermore, the slope for the GGB diagnostic plot of age segment 5+ to 65+ for female and male population is ***0.7758*** and ***0.7713***, respectively. Both values are close to one, however indicating that the coverage of death relative to the average of the coverage of both censuses is not complete 22.42 % and 22, 87% respectively. The intercept for GGB diagnostic plot for female population is negative, indicating increase in census coverage from 2004 to 2012. For the male population the value of the intercept is positive, which means that the census coverage from 2004 to 2012 declined.

FIGURE 6. 1: Observed versus fitted values mortality rates male population urban coastal area Suriname, 2004-2012 (age segment 5+ to 65+)



Source: Data CBB and GBS

FIGURE 6. 2: Observed versus fitted values mortality rates female population urban coastal area Suriname, 2004-2012 (age segment 5+ to 65+)



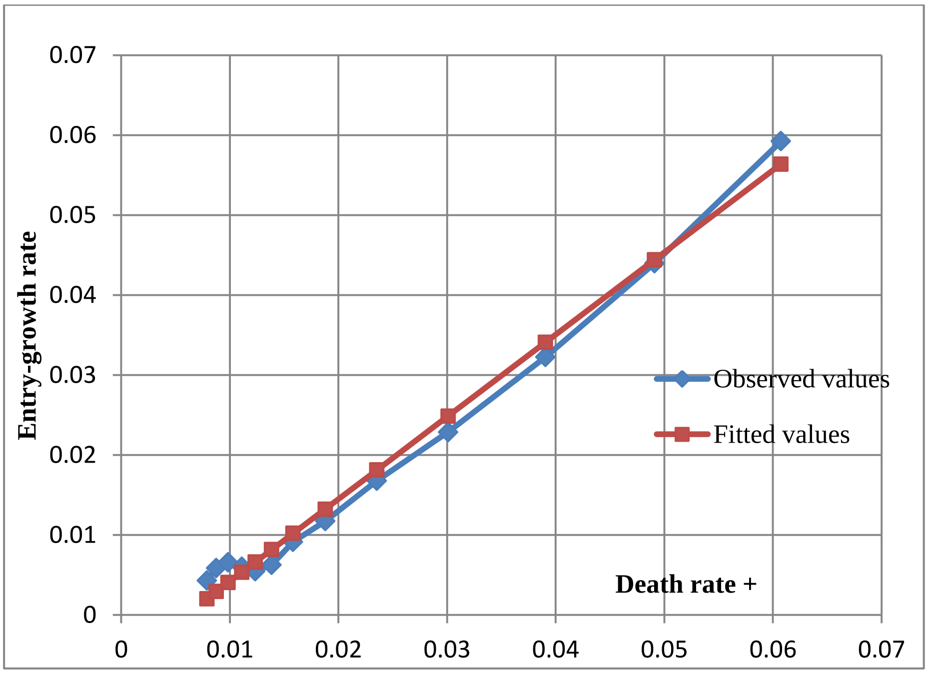
Source : Data CBB and GBS

6.2.1.2 Rural Coastal area GGB plots age segments 5+ to 65+

For the male population of the rural coastal area we observe that the GGB diagnostic plots for age segments 5+ to 65+ present goodness of fit for nearly all the age groups. As we can observe only the young age segments demonstrate possible violation of the assumption of no migration and the age varying of the census coverage and age varying of death.

As seen before, applying the GGB method the intercept captures any age variant change in census coverage and the slope estimates the coverage of death recording relative to an average of the coverage of two censuses (Hill and Choi, 2004). The encountered intercept for age segments 5+ and 65+ for male population rural coastal area is -0.0061 indicating an increase in census coverage from 2004 to 2012 and a systematic error in the growth rate, which arise for instance from a systematic change in census coverage between the first and second census (Hill, 2000; Hill and Choi, 2004). The value of the slope of 1.02 for age segment 5+ to 65+ indicates over- estimating coverage of death by 2%.

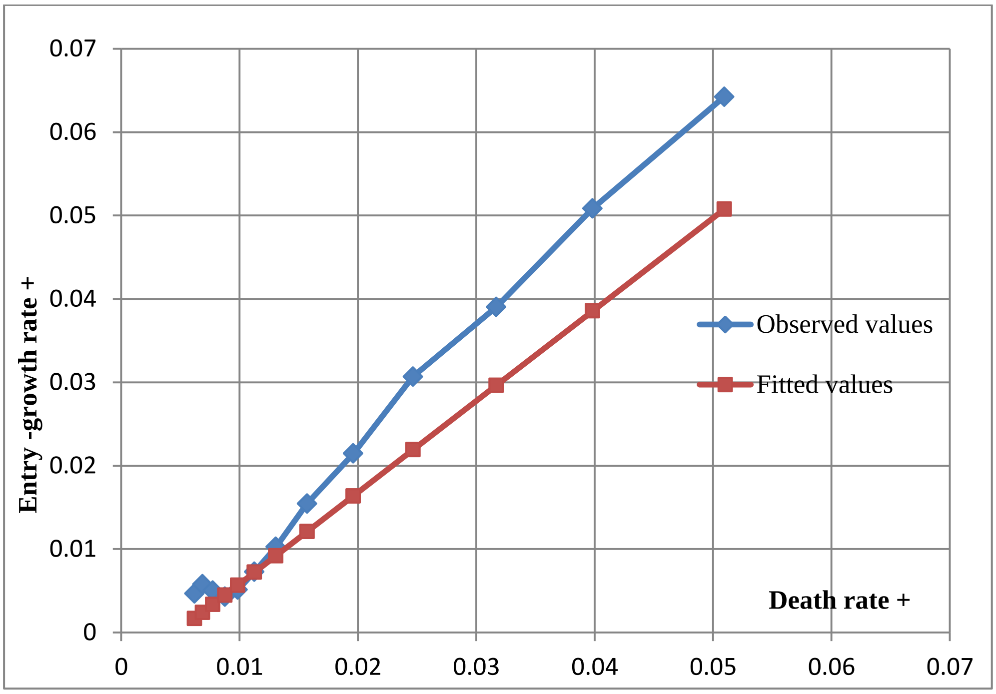
FIGURE 6. 3: Observed versus fitted values mortality rates male population rural coastal area Suriname, 2004-2012 (age segment 5+ to 65+)



Source : Data CBB and GBS

Considering the diagnostic plot of the GGB method age segment 5+ to 65+ (FIGURE 6.4) for female population of the rural coastal area we observe a different situation in relation to the male population of the rural coastal area. For the young ages and mature adult ages the observed values are higher than the fitted values, revealing over registration of deaths. For the age groups 20-24 up to 35-39 the observed values are approximately equal the fitted values. Value of the slope is 1.0966 and the intercept is -0.00512.

FIGURE 6. 4: Observed versus fitted value mortality rates female population rural coastal area Suriname, 2004-2012 (age segment 5+ to 65+)



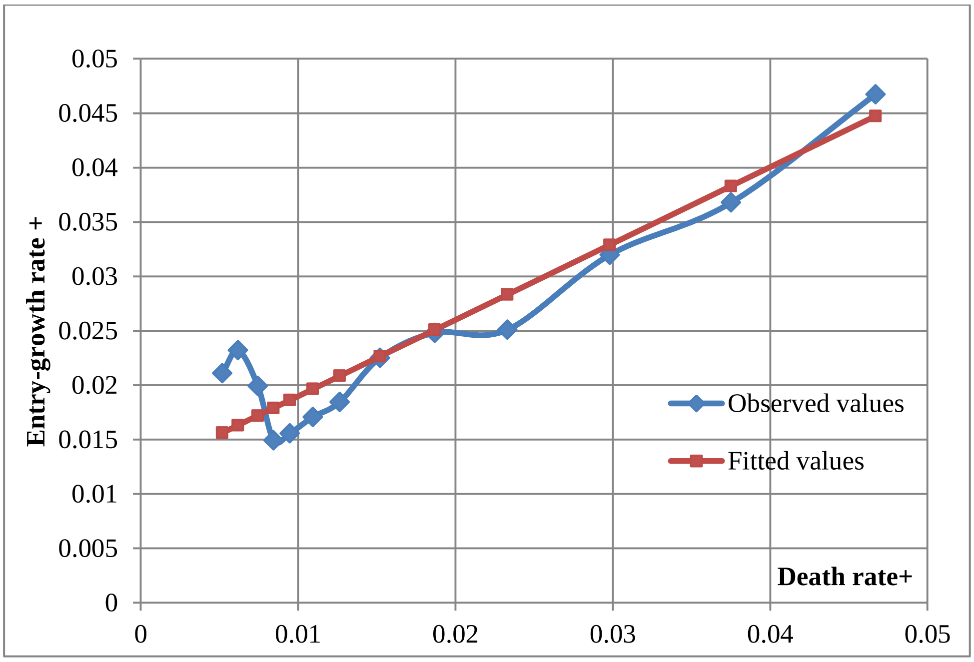
Source : Data CBB and GBS

6.2.1.3 Rural interior area GGB plots age segments 5+to 65+

Analysing the GGB diagnostic plot of the rural interior area for male population for age segments 5+ to 65+ we notice that, the orthogonal regression intercept the line of the fitted value in different points (FIGURE 6.5).

The age groups (20-24 up to 35-39 and 50-54) below the fitted line, indicates under register of death while the age groups above the fitted line (5-9 up to 15-19 and 65+) show over register of death. If we consider the slope of the line of the observed values versus fitted values the information is that the level of under registration of death is 29.84 % for male population in the rural interior area. Emigration (FIGURE B3 in ANNEX B), age varying coverage for census and the varying of death register may explain this result. Census coverage change for GGB, age segment 5+ to 65+ is 1.100 (TABLE ***6.1 on page 76***) meaning the coverage of Census 2004 was better than 2012. This may indicate the move of population between the first and the second census as the results in TABLE 2.5 ***on page 21*** reveal the volume of the migration flow of the rural interior area to the urban coastal and rural coastal area

FIGURE 6. 5: Observed versus fitted values mortality rates male population rural interior area Suriname, 2004-2012 (age segment 5+ to 65+)

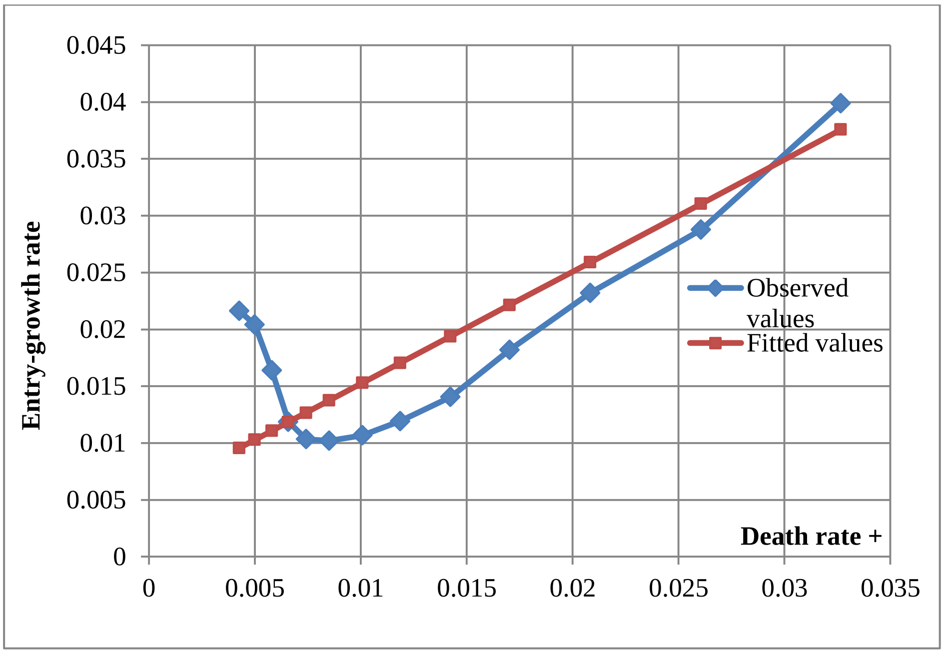


Source : Data CBB and GBS

Results of the GGB diagnostic plots for the female population of the rural interior area are somewhat different than for the male population. The GGB plot of age segment 5+ to 65+ (FIGURE 6.6) for the female population of the rural interior area shows that, the observed values are for nearly all age groups (20-24 up to 60-64) below the fitted line. This result indicates that under registration is a fact for young adult ages up to the beginning age groups of the elderly. As observe before, the GGB plot reveals where possible violation of the method occurs. The case of rural interior area for male and female population reflects the violation of no migration assumption of the GGB method and age varying of the register of death and the varying in census coverage.

Comparing the results of the GGB plot by age segment 5+ to 65+ between the three regions we observe that the results of the urban coastal area for the male and female population are the better ones. For the rural coastal area results of the male population are better than the female one. With respect to the results of the rural interior area we see that even for male as for female population we detect the violation of the assumption for the use of the GGB method. However, it is not possible to mention the degree of violation of each assumption of the DDM´s method.

FIGURE 6. 6: Observed versus fitted values mortality rates female population rural interior area Suriname, 2004-2012 (age segment 5+ to 65+)



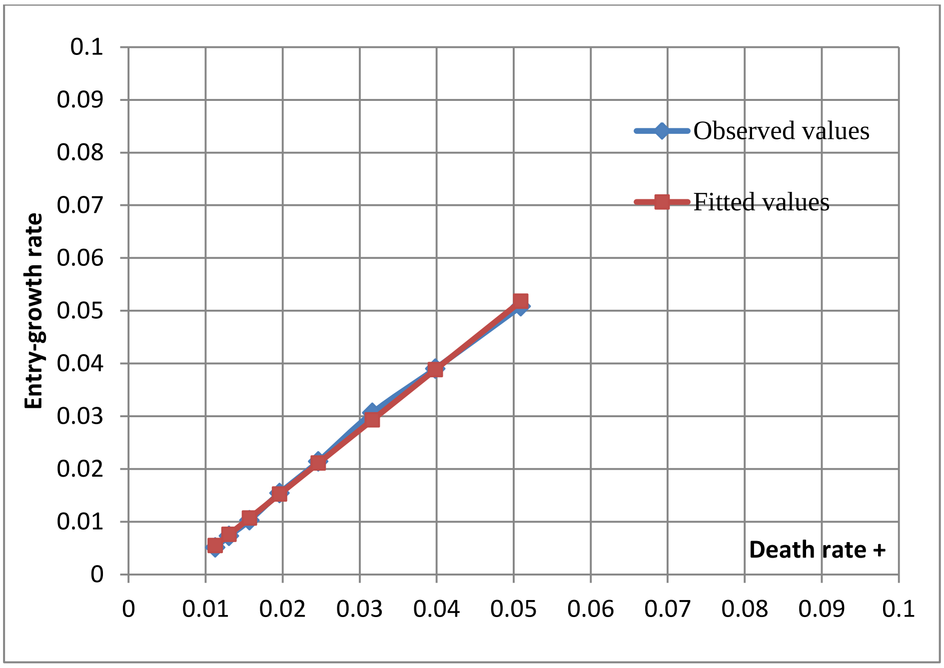
Source : Data CBB and GBS

6.2.1.4 Rural Coastal and Rural Interior area GGB plots age segments 30+ to 65+

In order to diminish the violation effects of migration for the rural coastal area, female population and for the rural interior area for male and female population the GGB-plots 30+ to 65+ are presented. FIGURES 6.7, 6.8 and 6.9 show the results for female population of the rural coastal area, male and female population of the rural interior area, respectively.

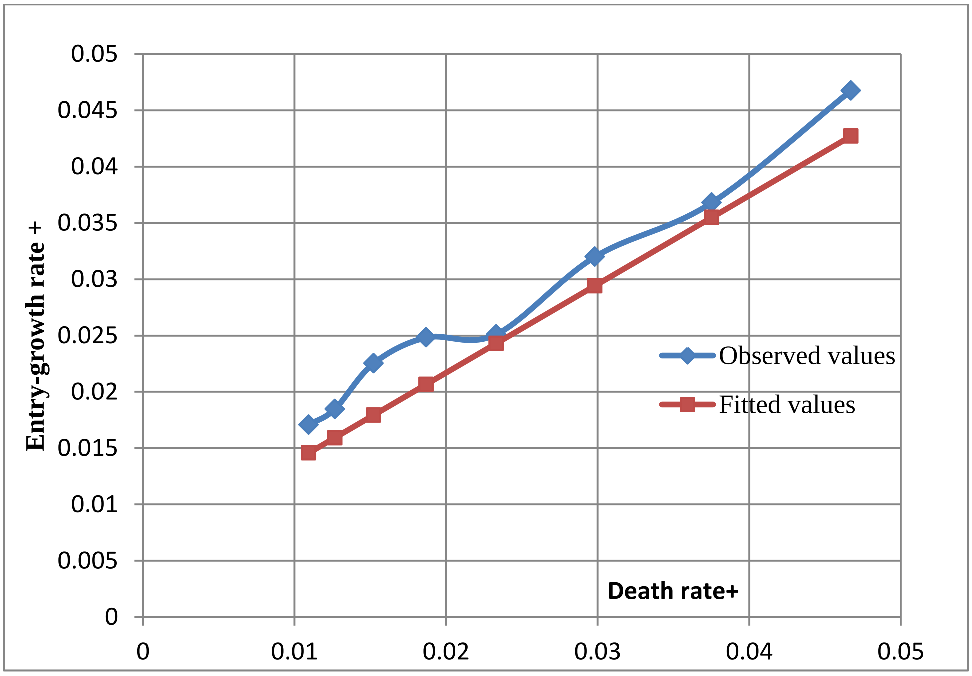
As can be seen the GGB plots adjusted by age segment 30+ to 65+ fits better than the GGB plots adjusted by age segment 5+ to 65+ in all the three cases. In other words, the adjustment is better for age segments without high proportion of peak migration. However, for the male population of the rural interior area the violation of varying of age of the death and the population, death omission due to migration is still notable in the GGB plot adjusted by age segment 30+ to 65+. The observed values are for all the age segments above the fitted values, indicating over estimation of mortality. For the female population of the rural coastal area and rural interior area the results with GGB adjusted by age segment 30+ to 65+ present a "***reasonable"*** to ***"good"*** goodness of fit.

FIGURE 6. 7: Observed versus fitted values mortality rates rural coastal area female population Suriname (age segment 30+ to 65+)



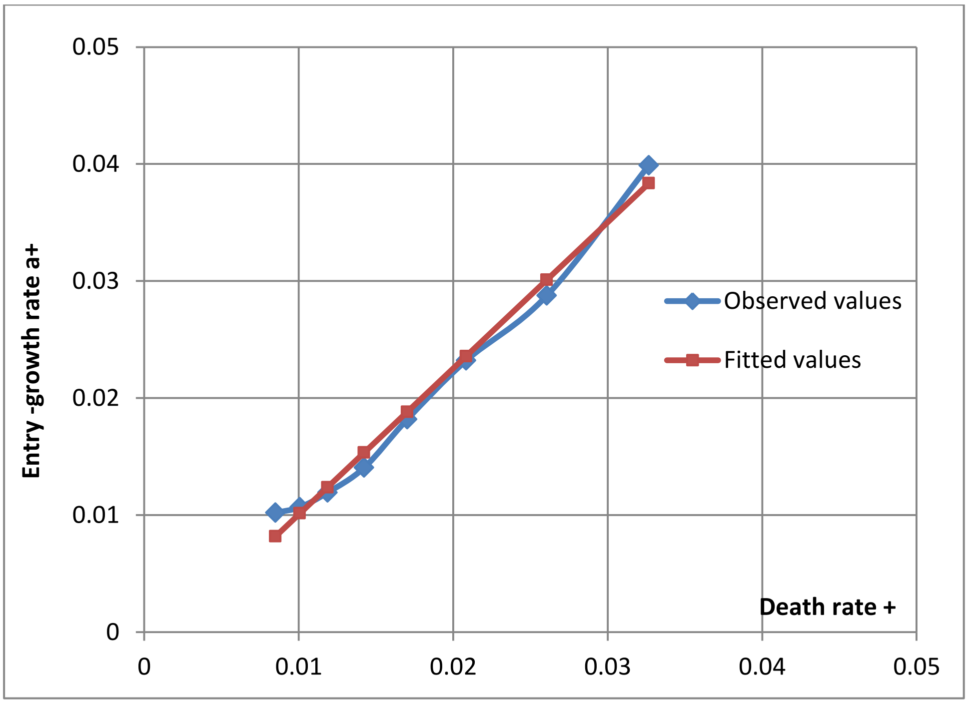
Source : Data CBB and GBS

FIGURE 6. 8: Observed versus fitted values mortality rates rural interior area male population Suriname (age segment 30+ to 65+)



Source : Data CBB and GBS

FIGURE 6. 9: Observed versus fitted values mortality rates rural interior area female population (age segment 30+ to 65+)



Source : Data CBB and GBS

6.2.2 Diagnostic plots SEG and GGB-SEG methods for male and female population for the main regions of Suriname

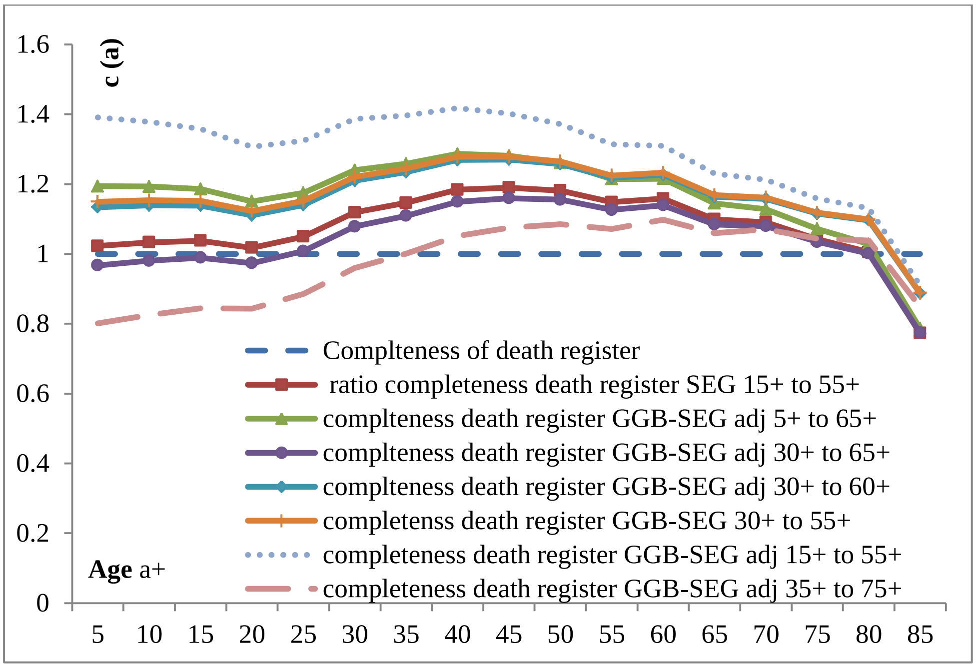
In this paragraph the presentation and analyse is done of the SEG plots based on age segment 15+ to 55+ and the GGB-SEG plots based on different age segments and by sex for the main regions of Suriname.

6.2.2.1 Urban Coastal area SEG and GGB-SEG plots

Analysing the male population of the urban coastal area we notice that the SEG method and the GGB-SEG method adjusted by age segment 5+ to 65+, 15+ to 55+, 30+ to 55+, 30+ to 60+ and 30+ to 65+ (FIGURE 6.10) over estimate mortality, and the death coverage is not constant starting for the age group 25-29 up to 85+. The overestimate of mortality starts at age group 25-29 and then decline again at age group 65 and over. The SEG method and the GGB-SEG adjusted by age segment 30+ to 65+ provide nearly the same results. The decline and increase in census coverage between census 2004 and 2012 for the male population of the urban coastal area is an explanation for the results of the application of the SEG and the GGB-SEG method. The positive net internal migration pattern for young adult ages might explain the overestimation of death registration. GGB-SEG adjusted by 5+ to 65+, 30+ to 55+

and 30+ to 60+ provides results that are very close to each other. The completeness of death reporting relative to population through GGB-SEG adjusted by 15+ to 55+ show high values of c (a), indicating considerable overestimation of mortality. Furthermore, GGB-SEG adjusted by age segment 15+ to 55+ can be considered as to be an outlier result in comparison to the other GGB-SEG plot. This outlier result might be attributed merely to the violation of the migration besides the presence of other errors and high male mortality in this age group. Moreover, all the plots in FIGURE 6.10 show varying of census coverage.

FIGURE 6. 10: Completeness of death reporting (a+) male population urban coastal area Suriname 2004-2012, SEG and GGB-SEG method for selected age segments



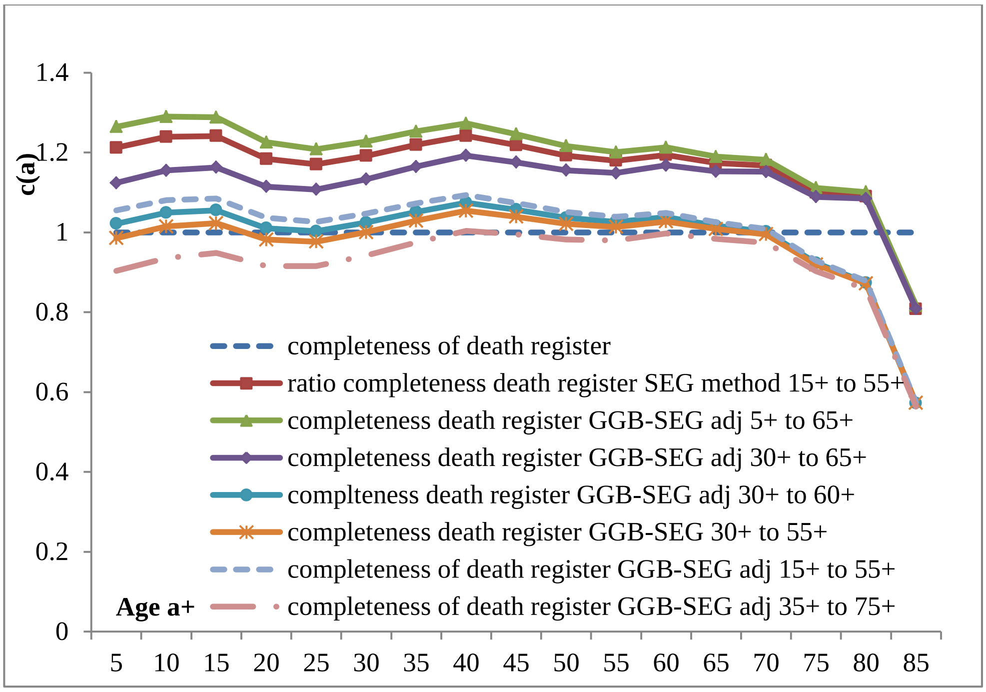
Source : Data CBB and GBS

As seen before, the Benneth and Horiuchi method works well in the absence of errors (Hill, 2000) which is not the case for the male population of the urban coastal area in Suriname. The GGB-SEG method adjusted by age segment 30+ to 65+, presents for the age groups of 30 years and younger and for age groups 80 and over, small under reporting of death and for ages below 30 years it is between 1.08% and 3.3%. The explanation for this result may be that the GGB-SEG adjusted by age segment of 30+ to 65+ is somewhat better for the age groups below 30 years. Over estimation of death coverage takes place for age groups 40-44 until 70-74. On the other hand GGB-SEG adjusted by age segment 35+ to 75+ presents out of all the GGB-SEG plots the highest under registration of deaths (between 4% and 19.86%) below 35 years, but the lowest over register of death (values between 1% and 8.5%) for ages

40 up to 80 years and over. All the plots in FIGURE 6.10 demonstrate not constancy of death coverage and thus indicating violation of the assumption of the application of the methods. Some plots show more violation of the assumption than others.

The results of the female population for the urban coastal area in Suriname (FIGURE 6.11) show a different result compared to the results of male population of the urban coastal area applying the SEG and GGB-SEG method adjusted by different age segments. The SEG and the GGB-SEG method adjusted by age segments 5+ to 65+ and 30+ to 65+ shows for all the age segments except 85+ over registration and also no constancy of death coverage. The best results in FIGURE 6.11 are observed by applying the GGB-SEG method adjusted by age segment 15+ to 55+, 30+ to 55+ and 30+ to 60+. The explanation is that this results show less over register of deaths and probably less age misreporting in relation to SEG and GGB-SEG adjusted by 5+ to 65+ and 30+ to 65+.

FIGURE 6. 11: Completeness of death reporting (a+) female population urban coastal area Suriname 2004-2012, SEG and GGB-SEG method for selected age segments



Source : Data CBB and GBS

GGB-SEG adjusted by age segment 35+ to 75+ present under registration below 40 years and above 70 years but values of c(a) very close to the unity between 40 years and 70 over. Completeness of death coverage very close to the unity in case of, applying GGB-SEG adjusted by age segment 30+ to 55+ is seen for age groups 10-14 and 15-19, 50-54 up to 70-

74 and thus presenting constancy of death coverage for these age segment. Under registration applying GGB-SEG, age segment 30+ to 60+ is between 8 % and 43% and occurred for age groups 75-79 up to 85+. Over registration for age groups 20-24, 25-29 and 30-34 is very small (between 1% and 2%) using GGB-SEG method adjusted by age segment 30+ to 60+. Remarkable is that for the female population of the urban coastal area the GGB-SEG method adjusted by age segment 30+ to 60+ and 30+ to 55+ show better results than in case of the male population for the urban coastal area. Possible explanation is that data errors for the female population are less than for the male population in this region, besides a possible lower peak migration in the age groups 30+ to 60+ and 30+ to 55+ for female population (FIGURE B7 IN ANNEX B). Other data errors, beside migration of female population may be less than male because, the results of census coverage change for female are better than for male as TABLES ***6.1, 6.2, 6.2 and 6.4*** on pages ***76, 78, 79 and 80*** present.

According to Hill, You and Choi (2009) the basic SEG method is affected by large errors when census coverage changes. Based on the results for male and female population of the urban coastal area, census coverage changes are less for female population than for male population.

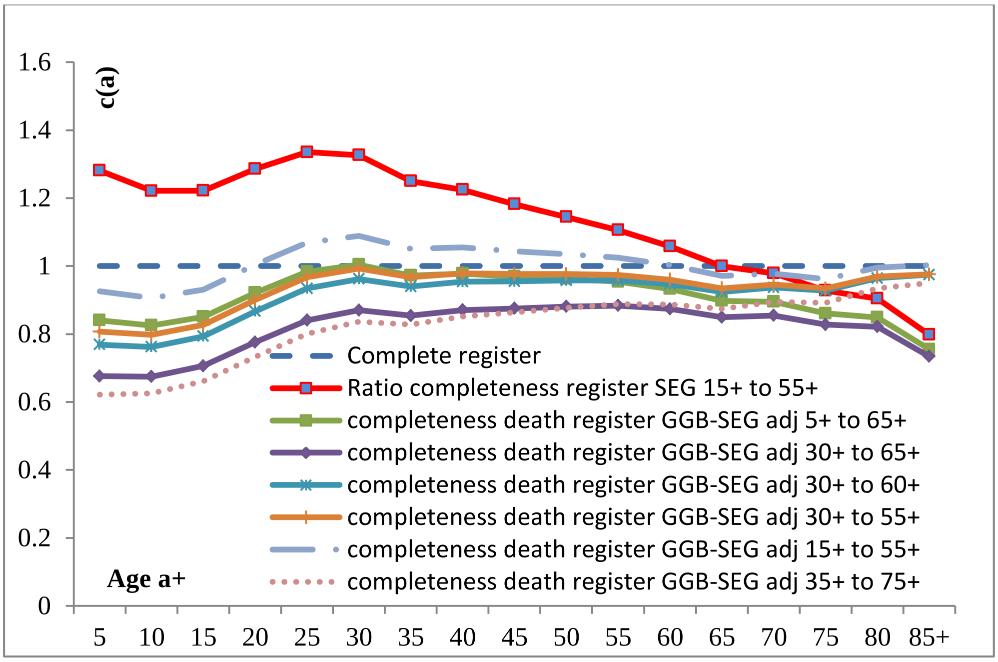
6.2.2.2 Rural Coastal area SEG and GGB-SEG plots

The SEG plots for male and female population of the rural coastal area overestimate mortality significantly (FIGURE 6.12 and 6.13), whereby for male population more than for female. The results of the GGB plot for female population proof the varying in census coverage change (FIGURE 6.4). Variations in the register of age of death for male and female population also have an effect on the SEG method. Even the GGB and SEG method overestimate mortality when ages of the living are exaggerated. However, the results of the Coale and Kisker (1986) measure for male and female population of the rural coastal have not showed exaggeration of the death, which has a less effect to overestimate mortality. The overestimate of mortality present, when applying the GGB and SEG method may be explained by a decline or increase of census coverage from the first to the second census, being that for the BH method it is more than for the GGB method (Hill, 2000).

TABLES ***6.1, 6.2, 6.3 and 6.4*** on pages ***76, 78, 79 and 80*** present values below one of the census coverage change in the rural coastal area for male and female population. Analysing the GGB-SEG plots adjusted by age segment 5+ to 65+, 15+ to 55+, 30+ to 65+, 30+ to 55+, 30+ to 60+ and 35+ to 75+ for the male and female population of the rural coastal area we observe that over estimation of completeness of death recording observed through the SEG method is eliminated. For some age groups in the adulthood of the male population, starting at age group 35-39 up to 60-64 some constancy in the death coverage is noticed applying the four GGB-SEG plots. The female population presents constancy of death coverage for all GGB-SEG plots starting with age group 30-34 until 55-59. The age groups below 30 years in the GGB-SEG plots of the female population of the rural coastal area (FIGURE 6.13) present variation of death coverage and completeness of death register of 61 % to 92%.

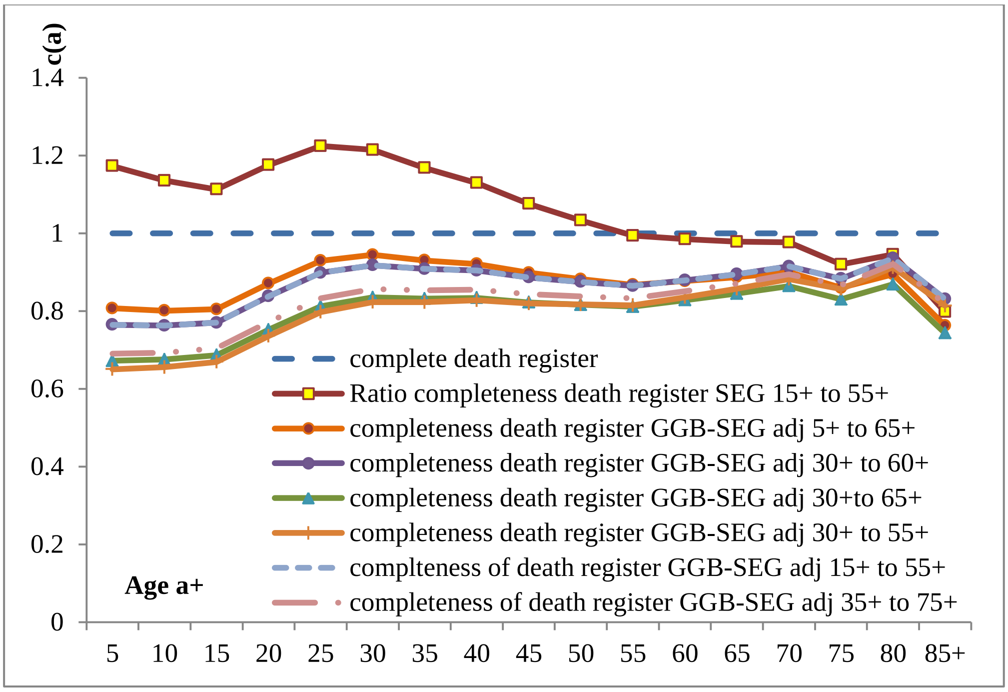
For the male population the results of the GGB-SEG adjusted by age segment 5+ to 65+ are close to the results of GGB-SEG adjusted by 30+ to 55+ and 30+ to 60+, from age 0+ up to 60+. However for the female population the results for GGB-SEG adjusted by age segment 30+ to 55+ are close to the results GGB-SEG adjusted by 15+ to 55+, 30+ to 65+ and 35+ to 75+. The results of the SEG method for male and female population may be considered outliers in relation to the results of the GGB-SEG plots. However, the SEG method informs about the existence of violation of the assumption of the DDM´s applied.

FIGURE 6. 12: Completeness of death reporting (a+) for male population rural coastal area of Suriname 2004-2012, SEG and GGB-SEG method for selected age segments



Source: Data CBB and GBS

FIGURE 6. 13: Completeness of death reporting (a+) for female population rural coastal area Suriname, 2004-2012, SEG and GGB-SEG method for selected age segments

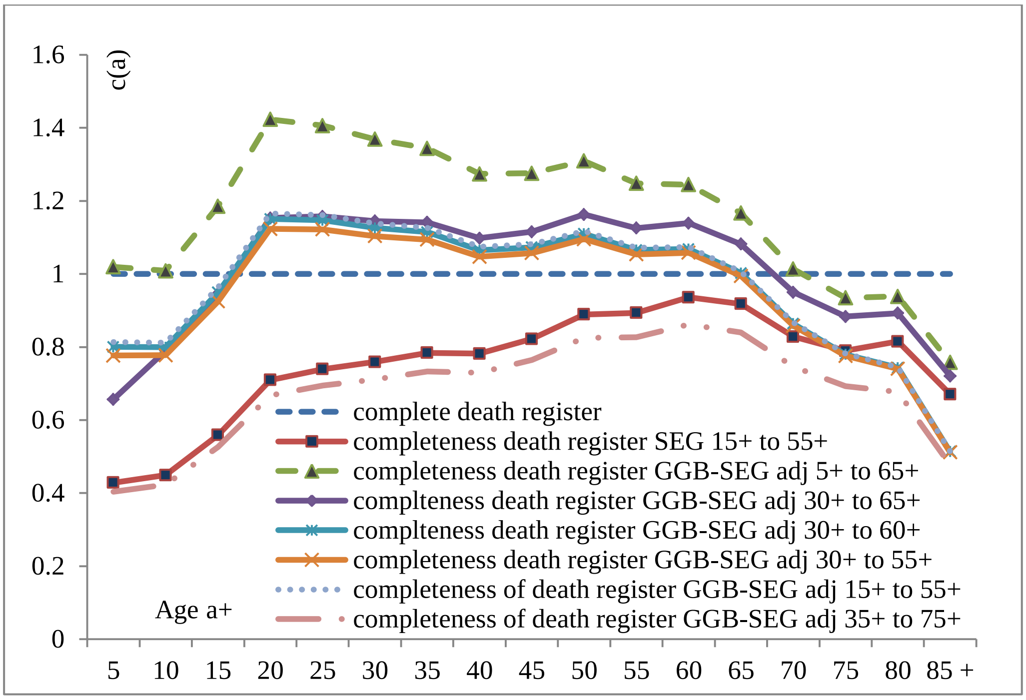


Source : Data CBB and GBS

6.2.2.3 Rural Interior area SEG and GGB-SEG plots

Applying the SEG method for the female and male population in the rural interior area we observe that the reverse situation happens in comparison to the male and female population of the rural coastal area. The application of the SEG method produces results for the rural interior area of underestimate of death coverage (FIGURE 6.14 and 6.15). The completeness of death register (SEG method) for the age group 0-4 years start for male and female population respectively at 42% and 39%, which mean a under registration of 58% and 61%. This result reveals the high under- registration in the rural interior area. The under-registration of death using SEG method reaches its minimum of 6.72% for male at age group 60-64 and of 16% for female population at age groups 40-44 and 45-49. Only the GGB-SEG plot 35+ to 75+ of the rural interior area, male and female population results in under registration for all the age groups just like the SEG method does. This under registration for all the age groups applying the GGB-SEG adjusted by age segment 35+ to 75+ may be related to omission of deaths due to not reported migration and the small scale of the population. The other GGB-SEG plots present over registration for the adult age groups of the male population.

FIGURE 6. 14: Completeness of death reporting (a+) male population rural interior area Suriname, 2004-2012, SEG and GGB-SEG method for selected age segments



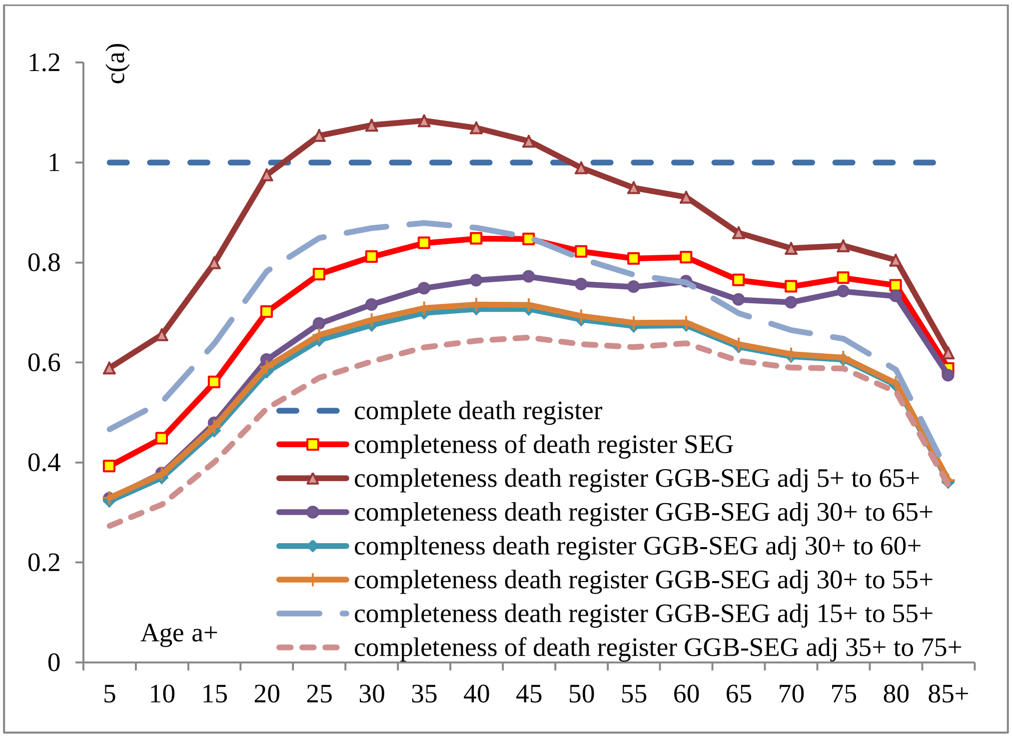
Source : Data CBB and GBS

For the female population of the rural interior area the results are different compared to the male population of the rural interior area. The GGB-SEG plot adjusted by age segment 5+ to 65+ produce over registration for the age groups 25-29 up to 45-49. the GGB-SEG plots adjusted by age segment, 15+ to 55+, 30+ to 65+, 30+ to 55+ and age segment 30+ to 60+ for the female population of the rural interior area (FIGURE 6.15) result in under registration for all the age groups. In other words, the result of the SEG plot is nearby to the results of the GGB-SEG plot adjusted by age segments 15+ to 55+, 30+ to 65+, 30+ to 55+ and 30+ to 60+. The indication is that the SEG plot and the mentioned GGB-SEG plots for female population of the rural interior area violate in the same way the assumptions of the methods; however, in different degrees and with different levels of data errors.

The GGB-SEG plot adjusted by age segment 15+ to 55+ produce the smallest under reporting of death for the age groups 5 up to 45 and over, compared to the other GGB-SEG plot of the female population. It is probably the female population of the rural interior area is less affected by migration than the male population in the ages below 45 years because of the smaller census coverage change from census 2012 to Census 2004 for female (TABLES ***6.1, 6.2, 6.3 and 6.4 on pages 76, 78, 79 and 80***)

Furthermore, the justification of the non-constancy of death coverage in the rural interior area can be explained by the fact that in this area omission of death may occur, great variation of yearly death register and age varying coverage for census and death count data, besides the presence of high negative net migration of the population. Another aspect is also the tiny scale of the population by sex in this area. Even the SEG and GGB-SEG method applied to female and male population of the rural interior area reveal possible violation of the assumptions for the application of the SEG and GGB-SEG method.

FIGURE 6. 15: Completeness of death reporting (a+) for female population rural interior area Suriname, 2004-2012, SEG and GGB-SEG method for selected age segments



Source: Data CBB and GBS

7. PROBABILITIES OF DYING BETWEEN 15 AND 60 YEARS OF AGE FOR SURINAME AND ITS MAIN REGIONS 2004-2012

In this chapter the probability function of dying ($_{n}q_{x}$) produced after the application of the GGB, SEG and GGB-SEG method, for different age segments (***with*** and ***without*** age groups of high net migration) will be adopted. This is done in order to calculate the probability of dying between 15 and 60 years of age $_{45}q_{15}$ for Suriname and it central regions, by methods, age segments and sex. The choice of age groups ***with*** and ***without*** high proportion of peak migration is done to observe possible effects of migration on $_{45}q_{15}$ .The probability $_{45}q_{15}$ is according to Hill, You and Choi (2009) a summary index of adult mortality. Furthermore, the differences of probability of dying $_{45}q_{15}$ between sex, by method and age segments for Suriname and its main regions will be determine by using the ratio: $\frac{_{45}q_{15}^{MALE}}{_{45}q_{15}^{FEMALE}}$.

7.1 Probabilities of dying between 15 and 60 years by DDM´s, selected age segments and sex for Suriname, 2004-2012

TABLE **7.1** and **7.2** (***on pages 100*** and ***101***) represent the matrix of the probability of dying $_{45}q_{15}$ for Suriname by GGB, SEG and GGB-SEG method and age segments with peak and without peak migration for respectively, male and female population. The adjusted probabilities of dying $_{45}q_{15}$ are according to Hill and Choi (2004) closer to the reality than the unadjusted probabilities of dying. Depending on the methods (GGB or SEG) applied and the chosen age segments the unadjusted ´probabilities of dying $_{45}q_{15}$ are lower or higher than the adjusted probabilities $_{45}q_{15}$. There exist differences in the adjusted probabilities of dying $_{45}q_{15}$ across the GGB, SEG and combined GGB-SEG methods. Moreover, there exists also differences in $_{45}q_{15}$ within the methods (between the age segments) for the cluster age segments ***with*** high proportion of peak migration and age segments ***without*** high proportion of peak migration (See TABLE **7.1** and **7.2**). There are differences in $_{45}q_{15}$ between methods and age segments because: ***1)*** some methods are more sensitive to migration than others; ***2)*** the move of people between two censuses affects the calculation of mortality rates and consequentially the $_{45}q_{15}$. With respect to the GGB-SEG method we can observe that there also exist differences between the observed $_{45}q_{15}$ and the adjusted ones by age segment, region and sex.

Considering the age segments with high proportion of peak migration for the male population we observe that the age segment 5+ to 65+ presents the highest probability of dying ***(0.2333)***, using the GGB-SEG method. However, this value is the observed adjusted (probability obtain after correction of the census population 2004) and it is ***0.028*** higher than the adjusted probability after applying SEG. Additionally, the GGB method for the same age segment has the lowest probability of dying ${}_{45}q_{15}$ (***0.1954***) between the adopted methods. On the other hand age segment 15+ to 75+ using the GGB method presents the highest probability of dying ${}_{45}q_{15}$ ***(0.2226)*** and the lowest probability of dying ${}_{45}q_{15}$ ***(0.2194)*** applying the SEG method. The unadjusted probability of dying ${}_{45}q_{15}$ ***(0.2320)*** is for age segments with high proportion of peak migration the closest to the results of the observed adjusted probability's required from the GGB-SEG method by age segments (TABLE ***7.1 on page 100***). This result of small difference implies that there exists minimum data error applying the GGB-SEG method for male population of Suriname.

Considering age segments without age groups of high proportion of peak migration we notice that the male population age segment 35+ to 75+ presents the highest adjusted probability ${}_{45}q_{15}$ **(*0.2399*)** using the GGB-SEG method and the lowest probability ${}_{45}q_{15}$ ***(0.2173)*** applying the SEG method. The age segment 30+ to 55+ has the lowest probability ${}_{45}q_{15}$ (***0.2025)*** applying the GGB method, while it has the highest observed adjusted probability of dying ${}_{45}q_{15}$ ***(0.2322***) for applying the GGB –SEG method. Hence, a proof that the observed adjusted ${}_{45}q_{15}$ using GGB- SEG method for age segments ***without*** high proportion of peak migration are for male population of Suriname on average (***0.2299***) nearly the same as the average (***0.2269***) of the adjusted probabilities of dying between 15 and 60 years of age.

It is important to mention that the lowest probability of dying between 15 and 60 years of age for male population in TABLE 7.1 is ***0.1760*** (GGB method age segment 15+ to 55+). Furthermore, we observe that the highest average of probability of dying ${}_{45}q_{15}$ are required applying the GGB-SEG method. For age segments with high proportion of peak migration the average ${}_{45}q_{15}$ for the GGB-SEG ***observed adjusted*** *is* ***(0.2329***. GGB-SEG method presents for age segments without high proportion of peak migration the highest stand deviation ***(0.0159)*** for the adjusted ${}_{45}q_{15}$. The standard deviation reveals how spread out the probabilities of dying ${}_{45}q_{15}$ is from the average by the use of the specific method.

TABLE 7. 1: Probability of dying by DDM´s for male population of Suriname, 2004-2012, by age segments including and excluding high proportion of peak migration

MALE SURINAME				
METHODS	***GGB***	***SEG***	***GGB-SEG (observed adjusted according to age segments)***	***GGB-SEG (adjusted according to age segments)***
Age segments *including proportion Peak Migration*	***Probabilities of dying $_{45}q_{15}$***			
15+ to 55+	*0.1760*	*0.2164*	**0.2342**	*0.1974*
5+ to 65+	0.1954	**0.2204**	0.2333	0.2089
15+ to 75+	**0.2226**	0.2194	*0.2306*	**0.2298**
10+ to 60+	0.1809	0.2183	0.2341	0.2000
15+ to 65+	0.2003	0.2170	0.2325	*0.2126*
MEAN	***0.1950***	***0.2183***	***0.2329***	***0.2097***
SDV	***0.0184***	***0.0017***	***0.0015***	***0.0128***
Unadjusted $_{45}q_{15}$	***0.2320***	***0.2320***	_	_
Age segments *excluding proportion Peak Migration*	***Probabilities of dying $_{45}q_{15}$***			
30+ to 55+	*0.2025*	*0.2109*	**0.2322**	*0.2098*
30+ to 65+	0.2123	0.2130	0.2306	0.2222
30+ to 75+	0.2305	0.2168	0.2286	0.2372
35+ to 65+	**0.2370**	0.2130	*0.2063*	0.2254
35+ to 75+	0.2332	**0.2173**	0.2300	**0.2399**
MEAN	***0.2173***	***0.2142***	***0.2299***	***0.2269***
SDV	***0.0156***	***0.0027***	***0.0017***	***0.0122***
Unadjusted $_{45}q_{15}$	***0.2320***	***0.2320***	_	_

Source: Data GBS and CBB

Note: Underlined probabilities are the minimum one by method; the bolded **probabilities** are the maximum one by method.

For the female population the probabilities of dying $_{45}q_{15}$ are lower than for the male population as expected. As Siveiro *et. al* (2011) mentioned Luy (2003) the rule is that man experience higher mortality than women in all the ages. The female population presents in the same way as the male population differences in probabilities of dying $_{45}q_{15}$ between the methods and age segments. As for the male population also the female population present for the age segment 15+ to 75+ the highest probability of dying $_{45}q_{15}$ ***(0.1316),*** the observed adjusted using the GGB-SEG method. The minimum probability of dying $_{45}q_{15}$ for the same age segment is ***0.1219*** after the application of the GGB method. However, within the GGB method age segment 15+ to 75+ present the highest probability $_{45}q_{15}$ between the age segments with high proportion of migration.

TABLE 7. 2: Probability of dying by DDM´s for female population of Suriname, by age segments including and excluding peak proportion of migration

FEMALE SURINAME				
METHODS	***GGB***	***SEG***	***GGB-SEG (observed adjusted according to age segments)***	***GGB-SEG (adjusted according to age segments)***
Age segments *including proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
15+ to 55+	0.1129	*0.1210*	0.1316	0.1248
5+ to 65+	0.1135	0.1227	**0.1318**	0.1250
15+ to 75+	**0.1219**	**0.1230**	0.1316	0.1262
10+ to 60+	*0.1116*	0.1217	**0.1318**	0.1235
15+ to 65+	0.1164	0.1217	*0.1314*	**0.1265**
MEAN	***0.1153***	***0.1220***	***0.1316***	***0.1252***
SDV	***0.0041***	***0.0008***	***0.0002***	***0.0012***
Unadjusted $_{45}q_{15}$	***0.1320***	***0.1320***	_	_
Age segments *excluding proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
30+ to 55+	**0.1261**	0.1203	0.1306	0.1319
30+ to 65+	*0.1211*	*0.1215*	**0.1308**	*0.1307*
30+ to 75+	0.1245	0.1233	0.1305	0.1333
35+ to 65+	0.1226	0.1218	0.1306	0.1315
35+ to 75+	**0.1261**	**0.1237**	0.1302	**0.1347**
MEAN	***0.1241***	***0.1221***	***0.1305***	***0.1324***
SDV	***0.0022***	***0.0014***	***0.0002***	***0.0016***
Unadjusted $_{45}q_{15}$	***0.1320***	***0.1320***	_	_

Source: Data GBS and CBB

Note: Underlined probabilities are the minimum one by method; the bolded probabilities are the maximum one by method.

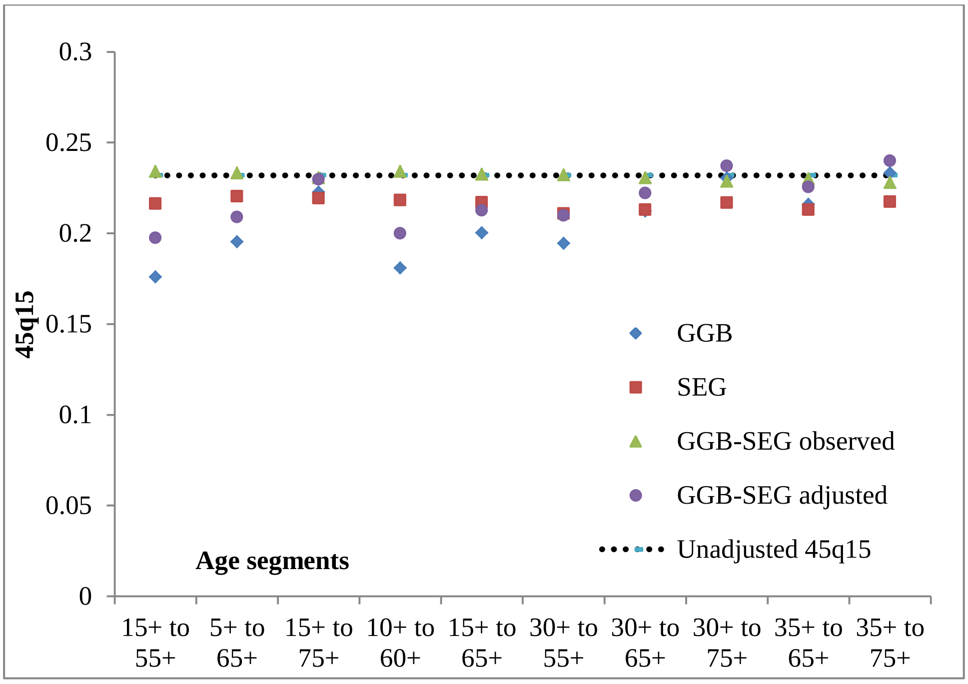
For male and female population, the highest probabilities of dying $_{45}q_{15}$ occur in general for age segments with the upper limit of 65+ or 75+ and when applying the method GGB, SEG or GGB-SEG method. As seen before, the GGB method is sensitive for age misreporting of the population and the death (Hill, You and Choi, 2009) and thus resulting in high probabilities for age segments with upper limit of 75+. Age misreporting is more common in older ages.

For the female population the lowest probability ${}_{45}q_{15}$ (***0.1116***) in TABLE 7.2 is for age segment 10+ to 60+ when applying the GGB method. The highest ${}_{45}q_{15}$ (***0.1347)*** is for age segment 35+ to 75+, when applying GGB-SEG method. As FIGURE 3.1 in CHAPTER 3 shows the highest percentage of death among female population occur in the elder age group 75-79. Furthermore, for male and female population the unadjusted probabilities of dying between 15 and 60 years of age by applying the DDM´s show values of ***0.2320*** and ***0.1320***, respectively. These values are close to the maximum values in TABLE 7.1 and 7.2 ***on pages 100 and 101***.

With respect to the average of ${}_{45}q_{15}$ for female population the highest one is for age segments ***with*** and ***without high*** proportion of migration when applying the GGB-SEG method. The standard deviation are the highest when applying the GGB method for the two clusters of age segments. A possible explanation that can be given is the fact that GGB method is more sensitive to age misreporting.

FIGURE 7.1 and 7.2 present ${}_{45}q_{15}$ for male and female population. These two figures make it possible to see clearly the behaviour of the probabilities of dying between 15 and 60 years by method and age segments. For male and female population, the GGB and the GGB-SEG adjusted ${}_{45}q_{15}$ show more fluctuations for selected age segments compared to the ${}_{45}q_{15}$ of the GGB-SEG method (observed) and the SEG method. The GGB-SEG method (observed) shows more constancy across age segments and values very close to the unadjusted probabilities of dying between 15 and 60 years of age. This once again may be an indication of small data errors, related to the assumptions of the methods applied

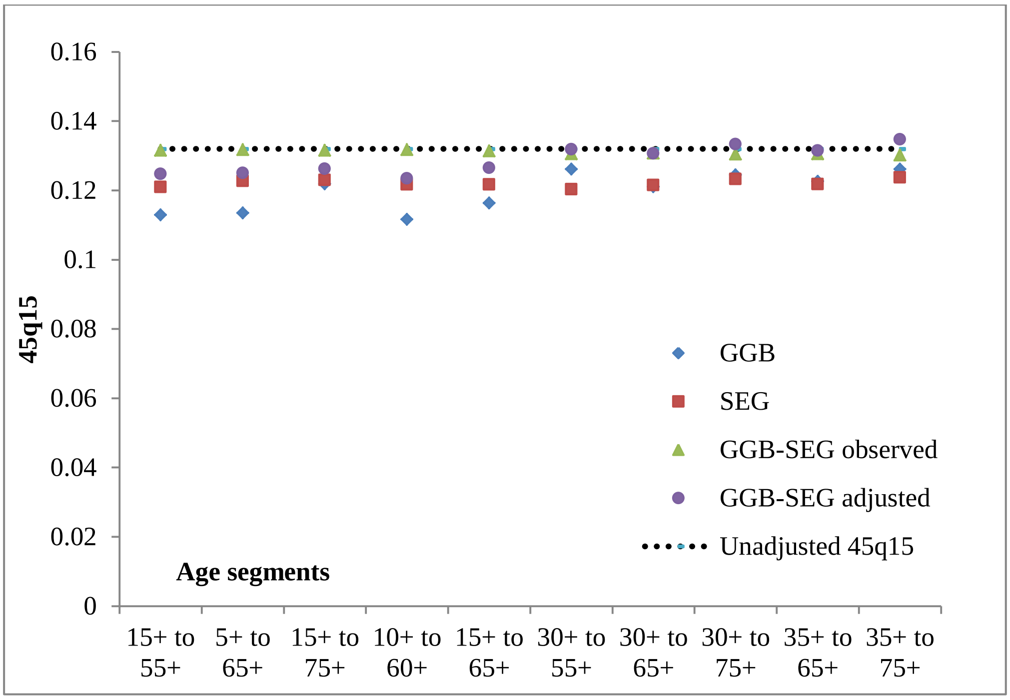
FIGURE 7. 1: Scatter plot probabilities of dying 45q15 by DDM´s and selected age segments for male population Suriname, 2004-2012



Source: Data GBS and CBB, 2004-2012

For almost all the age segments the ${}_{45}q_{15}$ for male and female population of Suriname by DDM´s are below the unadjusted ${}_{45}q_{15}$. For male population the values of ${}_{45}q_{15}$ GGB-SEG adjusted for age segment 30+ to 75+ and 35+ to 75+ are above the unadjusted probability of dying between 15 and 60 years. This result is for age segments ending in 75+, which are age groups with possibility of existing exaggeration of age. The values below the unadjusted ${}_{45}q_{15}$ may indicate the presence of the negative or positive net migration effects.

FIGURE 7. 2: Scatter plot of probabilities of dying 45q15 by DDM´s and selected age segments for female population of Suriname, 2004-2012



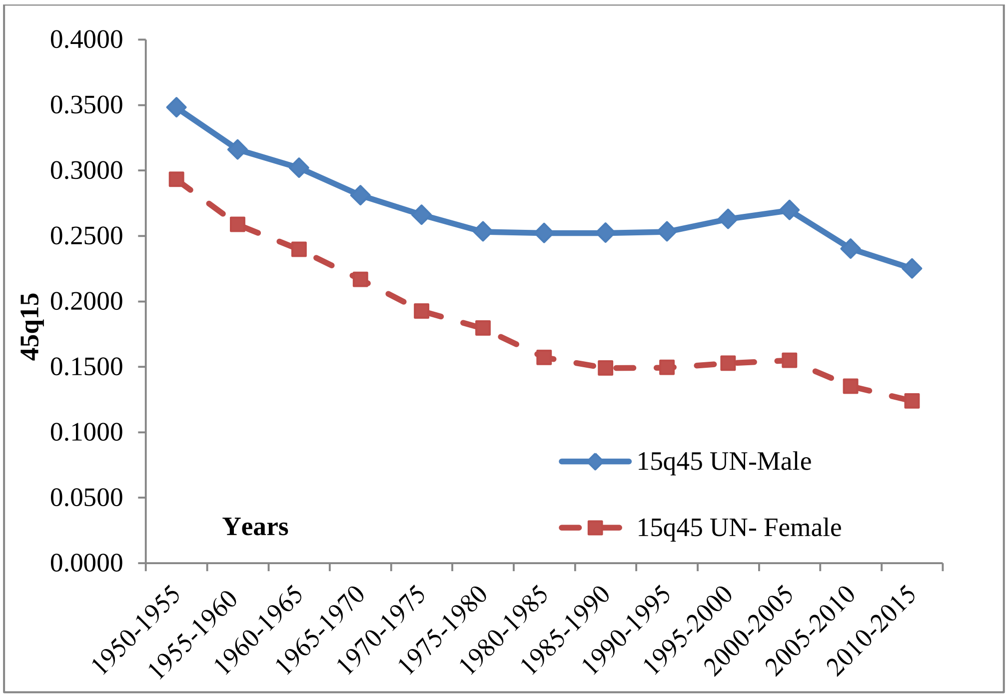
Source: Data GBS and CBB, 2004-2012

For the results of the female population we also observe that the ${}_{45}q_{15}$ GGB-SEG adjusted is higher than the unadjusted in case of age segments 30+ to 75+ and 35+ to 75+. For the male and female population of Suriname age segment 15+ to 75+ present less disperse values of ${}_{45}q_{15}$ for the different DDM´s. More disperse values of ${}_{45}q_{15}$ are for the age segments 15+ to 55+, 5+ to 65+ and 10+ to 60+ for male and female population. Less disperses values of ${}_{45}q_{15}$ by age segment and method may indicate that the degrees of violation of the assumption of the DDM´s are very close to each other's. More disperse values of ${}_{45}q_{15}$ by age segments show that the different assumptions are violated in different degrees by DDM´s and thus revealing the existence of the sensitivity of the DDM´s for specific data errors.

It is important to point out that other institutions which produce ${}_{45}q_{15}$ for Suriname are the United Nations (World Population Prospects 2012) and the World Health Organization (WHO). FIGURE 7.3 shows the results of the UN. The different results of ${}_{45}q_{15}$ required from the application of the GGB, SEG and Hybrid GGB SEG in this study are close to the values of ${}_{45}q_{15}$ from the United Nations for the period 2000-2005 and 2005-2010. For male and female population of Suriname the probability of dying between 15 and 60 years of age (UN) for the period 2005-2010 were respectively, ***0.2401*** and

0.1350. It is interesting to observe that in the period 1950-2015 the decline of ${}_{45}q_{15}$ occurred for both sexes and the distance between the curve for male and female population is widening. Just like in the developed world in the XX century the differences in mortality levels between man and woman increased substantially, due to the demographic changes (UN, 1988). These changes were due to the reduction of mortality levels and the change in the pattern of mortality.

FIGURE 7. 3: Probabilities of dying between 15 and 60 years of age for male and female population in Suriname, 1950-2015



Source: Data World Population Prospects 2012

The results of the WHO for male and female population in 2000 were ***0.2020*** and ***0.1430*** respectively. In 2012 WHO presents for male the value of ***0.1600*** for ${}_{45}q_{15}$ and ***0.09*** for female population. Remarkable is that the value of ${}_{45}q_{15}$ (***0.2401***) from the UN for the period 2005-2010 for male population is higher than the results on average of this study. But for female population the result of ${}_{45}q_{15}$ (***0.1350***) for the period 2005-2010 of the UN is much closer to the results on average in this study. The results of the WHO in 2012, on the other hand, are lower than the results in this study for male and female population. However, it is important to observe that the probabilities of dying between 15 and 60 years of age in this study are inter censal probabilities, while the probabilities of the WHO are yearly probabilities. It is interesting to observe that even for male as for female population the period 1990-2005 an increase of the ${}_{45}q_{15}$ occurred, however for male population more than for female. A possible explanation that may be given is, the effects of the not stable Socio–

Economic situation in Suriname for the period 1980-1990, due to the civil war in Suriname from 1986-1990 and the stop of financial aid of the Netherlands to the country[41]. The effect of the difficult period in Suriname was also notable in the fact that the execution of Census 2003 happened after 20 years of Census 1980.

7.2 Probabilities of dying between 15 and 60 years by DDM´s, selected age segments and sex for main regions of Suriname 2004-2012

The probabilities of dying from 15 to 60 years of age *(* $_{45}q_{15}$ *)* using GGB, SEG and combined strategy for the central regions of Suriname also show differences between the adopted methods, within the methods by age segments and by sex. Unadjusted probabilities are in case of the application of the GGB and SEG method sometimes higher or lower than the adjusted probabilities by age segments (TABLES ***7.3, 7.4***, ***7.5*** and ***7.6 on pages 108, 109, 113 and 114***).

When applying the SEG method for the two clusters of age segments in the urban coastal and rural coastal area the unadjusted probabilities are higher than the adjusted probabilities by age segments for male and female population. In this case the SEG method underestimates mortality. In the rural interior area the figure with respect to the results of the SEG method is different than for the urban coastal and rural coastal area. The results of $_{45}q_{15}$ by age segments and methods in TABLES 7.3, 7.4, 7.5 and 7.6 are also presented in the FIGURES 7.4 to 7.10. The figures permit to observe in a quick way the differences of $_{45}q_{15}$ by age segments and adopted method.

Applying the SEG method the probabilities of dying from 15 to 60 years of age ($_{45}q_{15}$) are higher than the unadjusted ones in the rural interior area for male and female population and for age segments with and without peak migration. For the male population in the rural interior area the unadjusted probability applying GGB and SEG method results in ***0.1640,*** while the highest probability applying SEG for this area is equal ***0.2140*** for age segment 5+ to 65+ (a difference of ***0.05***). Besides that, in the rural interior area, the SEG method for male population provides the highest probabilities for all the used age segments among the applied DDM´s. Furthermore, the standard deviation of the $_{45}q_{15}$ applying GGB method is higher for male population in the rural interior area than in the urban coastal and rural coastal area. This

[41] http://www.surinamewebquest.nl/binnenlandse_oorlog.html

means that ${}_{45}q_{15}$ are more dispersed within a specific method for the different age segments in the rural interior area for male population (FIGURE 7.6). Moreover, the GGB-SEG method (***adjusted***) has the highest average (***0.2513***) of ${}_{45}q_{15}$ for the urban coastal and for the rural coastal area the GGB produces the highest average value (***0.2216***) of ${}_{45}q_{15}$ within the methods adopted. The results of the scatter plot of probability of dying ${}_{45}q_{15}$ for male population of the urban coastal and rural coastal area are presented in FIGURE 7.4 and 7.5 on pages ***110 and 111***. As can be observed depending on the adopted DDM´s the distance between the unadjusted and adjusted probabilities of dying ${}_{45}q_{15}$ are small and in other cases are great. For the urban coastal area male population (FIGURE 7.4) the results of ${}_{45}q_{15}$ applying SEG are very close to the results of the unadjusted ones, while for the rural coastal area, male population there is a relatively greater distance between the ${}_{45}q_{15}$ applying SEG method and the unadjusted ${}_{45}q_{15}$.

TABLE 7. 3: Probability of dying by DDM´s for male population and main regions of Suriname, 2004-2012, by age segments including high proportion of peak migration

MALE MAIN REGIONS SURINAME				
METHODS	***GGB***	***SEG***	***GGB-SEG(observed according to age segments)***	***GGB-SEG(adjusted according to age segments)***
Urban Coastal				
Age segments *including proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
15+ to 55+	*0.1740*	*0.2260*	0.2528	*0.1923*
5+ to 65+	0.1984	**0.2283**	0.2513	0.2119
15+ to 75+	**0.2218**	0.2272	0.2490	**0.2232**
10+ to 60+	0.1811	0.2268	**0.2524**	0.1962
15+ to 65+	0.2008	0.2258	*0.2509*	0.2083
MEAN	**0.1952**	**0.2268**	**0.2513**	**0.2064**
SDV	**0.0187**	**0.0010**	**0.0015**	**0.0124**
Unadjusted $_{45}q_{15}$	***0.2494***	***0.2494***	_	_
Rural Coastal				
Age segments *including proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
15+ to 55+	*0.2064*	*0.1801*	**0.2297**	*0.2066*
5+ to 65+	0.2222	0.1838	0.2122	0.2262
15+ to 75+	**0.2402**	**0.1904**	*0.2101*	**0.2300**
10+ to 60+	0.2119	0.1823	0.2127	0.2099
15+ to 65+	0.2222	0.1851	0.2113	0.2207
MEAN	**0.2216**	**0.1843**	**0.2152**	**0.2187**
SDV	**0.0133**	**0.0039**	**0.0082**	**0.0101**
Unadjusted $_{45}q_{15}$	***0.2168***	***0.2168***	_	_
Rural Interior				
Age segments *including proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
15+ to 55+	0.1229	0.2073	0.1701	0.1559
5+ to 65+	0.1181	**0.2140**	0.1713	*0.1394*
15+ to 75+	**0.1747**	0.2004	*0.1665*	**0.1935**
10+ to 60+	*0.1138*	0.2108	**0.1712**	0.1504
15+ to 65+	0.1280	0.2008	0.1698	0.1600
MEAN	**0.1315**	**0.2067**	**0.1698**	**0.1598**
SDV	**0.0247**	**0.0060**	**0.0019**	**0.0203**
Unadjusted	***0.1640***	***0.1640***	_	_

Source : Data CBB and GBS

Note: With respect to the adjusted probabilities the underlined and cursive probabilities are the minimum one by method; the bolded probabilities are the maximum one by method.

TABLE 7. 4: Probability of dying by DDM´s for male population and main regions of Suriname, 2004-2012, by age segments excluding high proportion of peak migration

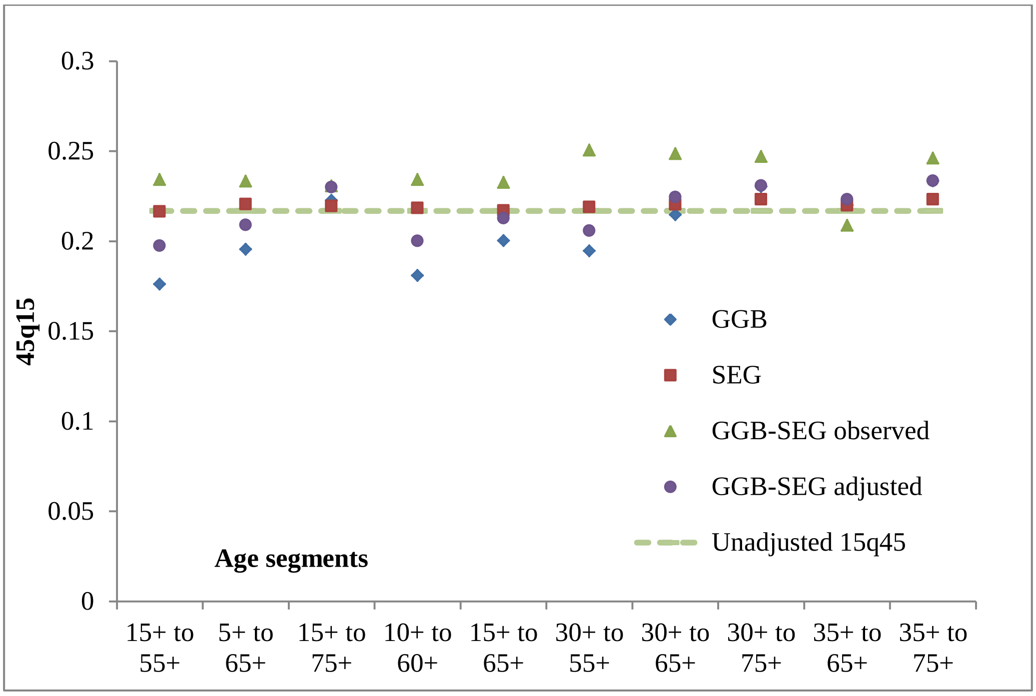
MALE MAIN REGIONS SURINAME				
METHODS	***GGB***	***SEG***	***GGB-SEG (observed according to age segments)***	***GGB-SEG (adjusted according to age segments)***
Urban Coastal				
Age segments *excluding proportions Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
30+ to 55+	*0.1945*	*0.2188*	**0.2505**	*0.1923*
30+ to 65+	0.2146	0.2202	0.2486	0.2243
30+ to 75+	0.2303	**0.2231**	0.2469	0.2307
35+ to 65+	0.2200	0.2194	0.2477	0.2232
35+ to 75+	**0.2335**	0.2228	*0.2460*	**0.2335**
MEAN	***0.2186***	***0.2210***	***0.2402***	***0.2235***
SDV	***0.0155***	***0.0020***	***0.0176***	***0.0108***
Unadjusted $_{45}q_{15}$	***0.2494***	***0.2494***	_	_
Rural Coastal				
Age segments *excluding proportions Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
30+ to 55+	*0.2189*	0.1834	**0.2113**	*0.2156*
30+ to 65+	0.2360	0.1897	0.2098	**0.2372**
30+ to 75+	0.2455	0.1960	0.2087	0.2341
35+ to 65+	0.2366	0.1932	0.2097	0.2280
35+ to 75+	**0.2465**	**0.1997**	*0.2084*	0.2349
MEAN	***0.2367***	***0.1924***	***0.2096***	***0.2300***
SDV	***0.0111***	***0.0062***	***0.0011***	***0.0087***
Unadjusted $_{45}q_{15}$	***0.2168***	***0.2168***	_	_
Rural Interior				
Age segments *excluding proportions Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
30+ to 55+	*0.1262*	**0.1959**	**0.1697**	*0.1589*
30+ to 65+	0.1314	0.1904	0.1676	0.1621
30+ to 75+	0.1826	0.1920	0.1647	0.2019
35+ to 65+	0.1306	*0.1879*	0.1694	0.1633
35+ to 75+	**0.1857**	0.1902	*0.1641*	**0.2053**
MEAN	***0.1513***	***0.1913***	***0.1671***	***0.1783***
SDV	***0.0301***	***0.0030***	***0.0026***	***0.0232***
Unadjusted $_{45}q_{15}$	***0.1640***	***0.1640***	_	_

Source : Data CBB and GBS

Note: With respect to the adjusted probabilities the underlined and cursive probabilities are the minimum one by method; the bolded probabilities are the maximum one by method.

The values of the GGB-SEG observed ${}_{45}q_{15}$ are very close to the unadjusted ones of the male population for the rural coastal area. In case of the urban coastal area the GGB-SEG observed ${}_{45}q_{15}$ are overall higher than the unadjusted ones and depending on the age segments the values are close or on a distance from the unadjusted ${}_{45}q_{15}$. Small and great distance between the unadjusted probabilities of dying ${}_{45}q_{15}$ and the adjusted ones by method may indicate less or more violation of the methods applied, respectively. In other words, higher or lower values of ${}_{45}q_{15}$ by method applied and selected age segment compared to the unadjusted ones may indicate that the assumption of the use of the DDM´s are in some way violated.

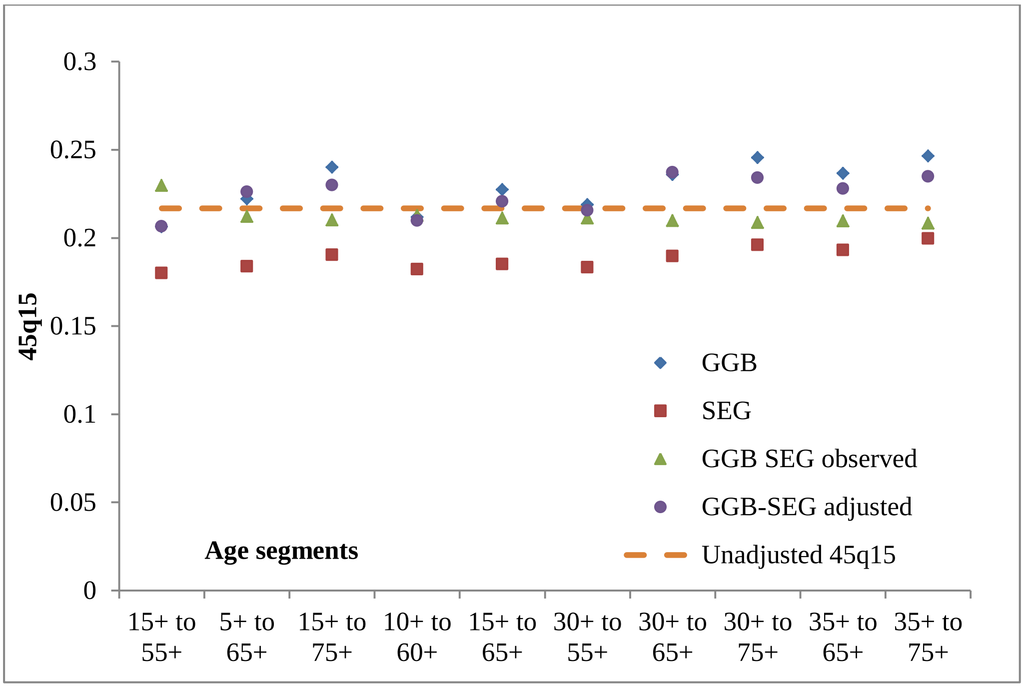
FIGURE 7. 4: Scatter plot of probability of dying 45q15 by methods and selected age segments for male population urban coastal area Suriname, 2004-2012



Source: Data GBS and CBB, 2004-2012

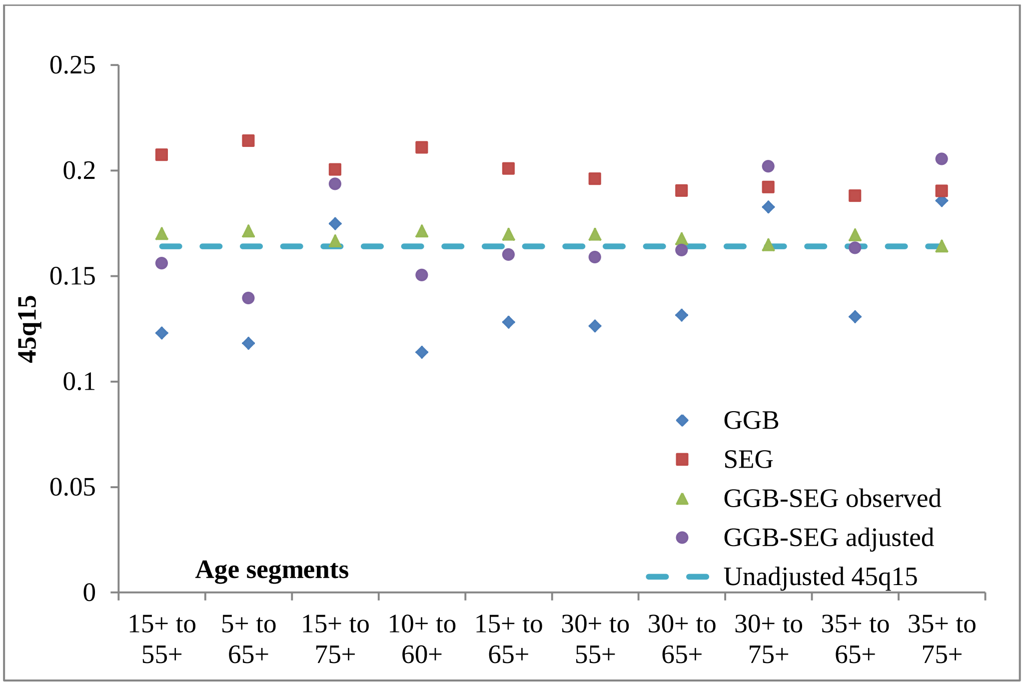
For male population of the rural interior area the scatter plot (FIGURE 7.6) present a different behaviour with respect to ${}_{45}q_{15}$ by methods and age segments in relation to the urban costal area and the rural interior area (FIGURE 7.4 and 7.5).

FIGURE 7. 5: Scatter plot of probabilities of dying 45q15 by method and selected age segments for male population rural coastal area Suriname, 2004-2012



Source: Data GBS and CBB, 2004-2012

FIGURE 7. 6: Scatter plot of probabilities of dying 45q15 by methods and selected age segments for male population rural interior area Suriname, 2004-2012



Source: Own elaboration based on data GBS and CBB, 2004-2012

Remarkable is that the lowest probability of dying ${}_{45}q_{15}$ by DDM´s and age segments for male population are in the rural interior area, being a not expected result due to the socio – economic development of this area (HAD, 2013). A possible explanation that may be given is that the effect of male migration in the small scale population of the rural interior area produces the lower probabilities. Besides that the existence of the census coverage change, age varying in the register of death in the small population and the possibility of existence of death omission ***(violation of the assumptions of DDM´s)*** have an effect on the results.

Observing the female population of the rural interior area (TABLE ***7.6 on page 114***) we notice that the probability of dying from 15 to 60 (${}_{45}q_{15}$) using SEG method produce the highest probability of ***0.1293*** for age segment 35+ to 75+ followed by the probability of ***0.1275*** for age segment 30+ to 65+. The unadjusted probability of dying from 15 to 60 years of age (${}_{45}q_{15}$) for female population in the rural interior area is ***0.1057,*** using GGB and SEG method. As seen on country level and for the main regions the age segments with upper limit 75+, applying the GGB method provides in general the highest probability for age segments ***with*** and ***without*** peak migration, for male and female population. In the rural coastal area the probabilities ${}_{45}q_{15}$ for female population are higher using the GGB and GGB-SEG adjusted method by age segments compared to the SEG method (TABLE ***7.5*** and ***7.6 on pages 113 and 114***)

Considering the GGB-SEG method ***without*** age segments of peak migration we observe that the GGB-SEG ***adjusted*** provide higher probabilities for male and female population in comparison to the GGB-SEG method, ***observed*** in the rural coastal area of Suriname. In TABLE ***7.6*** (***page 114***) for instance we observe that for the female population of the rural interior area the adjusted ${}_{45}q_{15}$ is ***0.1372*** for age segment 30+ to 65+ by applying GGB-SEG and the observed ${}_{45}q_{15}$ is ***0.1047***. On the other hand, for the female population of the urban coastal area for age segment 30+ to 65+ applying GGB-SEG method, the adjusted probability of dying between 15 and 60 years is ***0.1186*** and the observed adjusted one is ***0.1363.***

Overall the lowest probability of dying between 15 and 60 years of age for female population are in the urban coastal area using the DDM´s by different age segments. This result is consistent compared to the socio–economic development of the urban coastal area.

TABLE 7. 5: Probability of dying by DDM´s for female population and main regions of Suriname, 2004-2012, by age segments including high proportion of peak migration

FEMALE MAIN REGIONS SURINAME				
METHODS	***GGB***	***SEG***	***GGB-SEG (observed according to age segments)***	***GGB-SEG (adjusted according to age segment)***
Urban Coastal				
Age segments *including proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
15+ to 55+	*0.1077*	0.1151	0.1366	0.1296
5+ to 65+	0.1079	0.1150	**0.1371**	0.1123
15+ to 75+	**0.1137**	**0.1163**	*0.1362*	**0.1354**
10+ to 60+	0.1067	*0.1149*	0.1366	*0.1292*
15+ to 65+	0.1078	0.1154	0.1366	*0.1302*
MEAN	***0.1088***	***0.1153***	***01366***	***0.1273***
SDV	***0.0028***	***0.0006***	***0.0003***	***0.0088***
Unadjusted $_{45}q_{15}$	***0.1369***	***0.1369***	_	_
Rural Coastal				
Age segments *including proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
15+ to 55+	0.1515	*0.1211*	0.1322	0.1498
5+ to 65+	*0.1473*	0.1229	**0.1327**	0.1496
15+ to 75+	**0.1528**	**0.1263**	*0.1321*	**0.1502**
10+ to 60+	0.1489	0.1223	0.1325	*0.1477*
15+ to 65+	0.1507	0.1352	0.1323	0.1489
MEAN	***0.1502***	***0.1256***	***0.1324***	***0.1492***
SDV	***0.0022***	***0.0057***	***0.0002***	***0.0010***
Unadjusted $_{45}q_{15}$	***0.1353***	***0.1353***	_	_
Rural Interior				
Age segments *including proportion Peak Migration*	***Probabilities of dying*** $_{45}q_{15}$			
15+ to 55+	*0.0918*	*0.1335*	0.1074	0.1588
5+ to 65+	0.1043	**0.1427**	**0.1078**	*0.1156*
15+ to 75+	**0.1231**	0.1338	*0.1060*	0.1519
10+ to 60+	0.0954	0.1380	0.1077	0.1310
15+ to 65+	0.1136	0.1333	0.1077	0.1313
MEAN	***0.1056***	***0.1363***	***0.1073***	***0.1377***
SDV	***0.0129***	***0.0041***	***0.0008***	***0.0018***
Unadjusted $_{45}q_{15}$	***0.1057***	***0.1057***	_	_

Source : Data CBB and GBS

Note: With respect to the adjusted probabilities the underlined and cursive probabilities are the minimum one by method; the bolded probabilities are the maximum one by method

TABLE 7. 6: Probability of dying by DDM´s for female population and main regions of Suriname, 2004-2012, by age segments excluding high proportion of peak migration

FEMALE MAIN REGIONS SURINAME				
METHODS	***GGB***	***SEG***	***GGB-SEG (observed according to age segments)***	***GGB-SEG (adjusted according to age segments)***
Urban Coastal				
Age segments excluding proportion Peak Migration	***Probabilities of dying*** $_{45}q_{15}$			
30+ to 55+	0.1129	*0.1148*	0.1361	0.1329
30+ to 65+	*0.1098*	0.1153	**0.1363**	*0.1186*
30+ to 75+	0.1154	**0.1166**	0.1358	0.1374
35+ to 65+	0.1116	0.1152	0.1361	0.1334
35+ to 75+	**0.1165**	**0.1166**	*0.1356*	**0.1385**
MEAN	**0.1132**	**0.1157**	***0.1360***	***0.1322***
SDV	**0.0027**	**0.0008**	**0.0003**	**0.0080**
Unadjusted $_{45}q_{15}$	***0.1369***	***0.1369***	_	_
Rural Coastal				
Age segments ***excluding proportion Peak Migration***	***Probabilities of dying*** $_{45}q_{15}$			
30+ to 55+	**0.1663**	*0.1235*	*0.1308*	**0.1605**
30+ to 65+	0.1560	0.1267	0.1315	0.1565
30+ to 75+	0.1554	0.1295	0.1315	0.1521
35+ to 65+	0.1553	0.1290	**0.1316**	0.1524
35+ to 75+	*0.1552*	**0.1317**	0.1315	*0.1518*
MEAN	***0.1576***	**0.1281**	**0.1314**	**0.1547**
SDV	***0.0049***	**0.0031**	**0.0003**	**0.0038**
Unadjusted $_{45}q_{15}$	***0.1353***	***0.1353***	_	_
Rural Interior				
Age segments ***excluding proportion Peak Migration***	***Probabilities of dying*** $_{45}q_{15}$			
30+ to 55+	*0.1161*	0.1260	**0.1055**	0.1473
30+ to 65+	0.1301	0.1275	0.1047	*0.1372*
30+ to 75+	0.1308	0.1292	0.1047	**0.1750**
35+ to 65+	**0.1347**	*0.1274*	*0.1042*	0.1621
35+ to 75+	0.1323	**0.1293**	0.1045	0.1622
MEAN	**0.1288**	**0.1279**	**0.1047**	**0.1568**
SDV	**0.0073**	**0.0014**	**0.0005**	**0.0147**
Unadjusted $_{45}q_{15}$	***0.1057***	***0.1057***	_	_

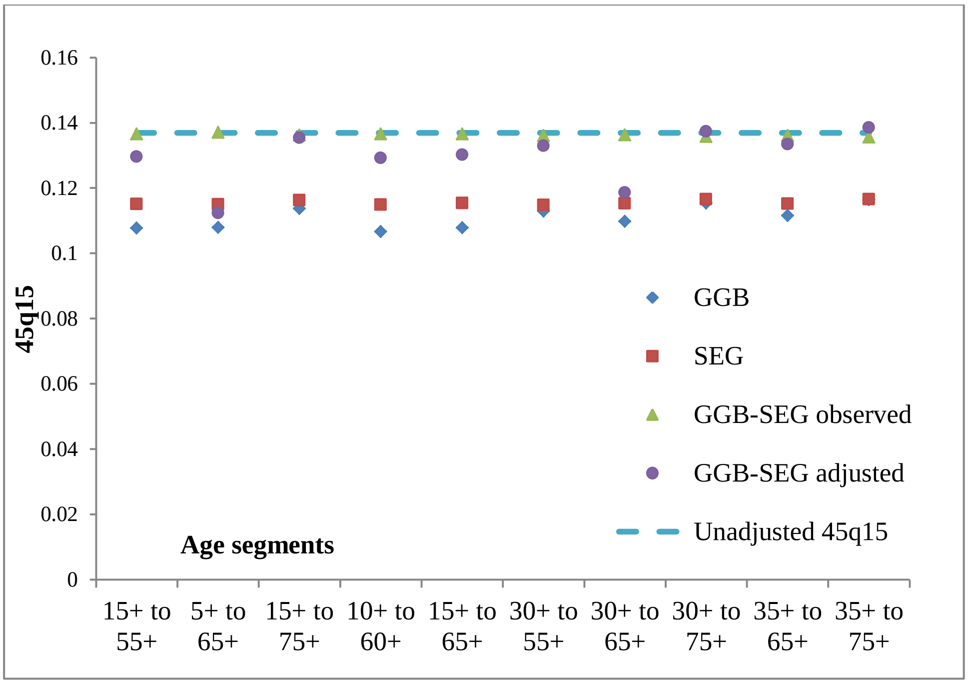
Source : Data CBB and GBS

Note: With respect to the adjusted probabilities the underlined and cursive probabilities are the minimum one by method; the bolded probabilities are the maximum one by method.

Another result which also calls attention is firstly that the lowest average ***(0.1073)*** of $_{45}q_{15}$ for female population within the main regions is for the GGB-SEG observed values and by age segments without peak migration in the rural interior area. Furthermore, the GGB method by age segments including high proportion of migration for female population in the rural interior area produces the second lowest average ***(0.1056)*** of $_{45}q_{15}$ within the three main regions in Suriname. This average of the rural interior area is close to the average of the urban coastal area and thus requires some explanation, which cannot be given very easy.

FIGURE 7.7, 7.8 and 7.9 show the differences between the results of $_{45}q_{15}$ by DDM´s and age segments for female population of the main regions of Suriname. As have been observed for the male population also the female population of the rural interior area presents very dispersed $_{45}q_{15}$ by methods and age segments.

FIGURE 7. 7: Scatter plot of probabilities of dying 45q15 by methods and selected age segments for female population urban coastal area Suriname, 2004-2012

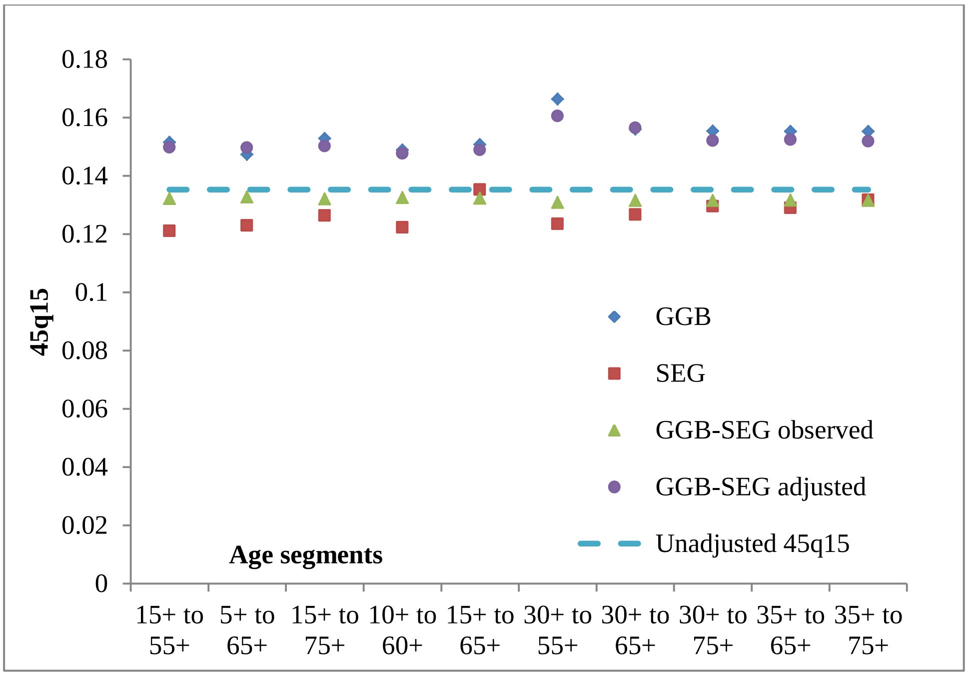


Source: Data GBS and CBB, 2004-2012

Comparing the female results of the urban coastal area with the rural interior area (FIGURE 7.7 and 7.9) we observe that for all the DDM´s by age segments in the urban coastal area the results of adjusted $_{45}q_{15}$ are below the values of the unadjusted $_{45}q_{15}$. For the rural interior area (FIGURE 7.9) the situation is the reverse one, in the sense that the values of adjusted

$_{45}q_{15}$ are below and merely above the unadjusted $_{45}q_{15}$. Analysing the results of the rural coastal area (FIGURE 7.8) we observe that for SEG and GGB-SEG ***observed***, $_{45}q_{15}$ are below the unadjusted ones. The results of GGB and GGB-SEG ***adjusted*** are greater than the unadjusted $_{45}q_{15}$ for female population in the rural coastal area. Just as the analyse done for male population we observe that, the greater or smaller values of the adjusted $_{45}q_{15}$ are compared to the unadjusted ones there exist a relation with the violation of the assumption for the use of the DDM´s.

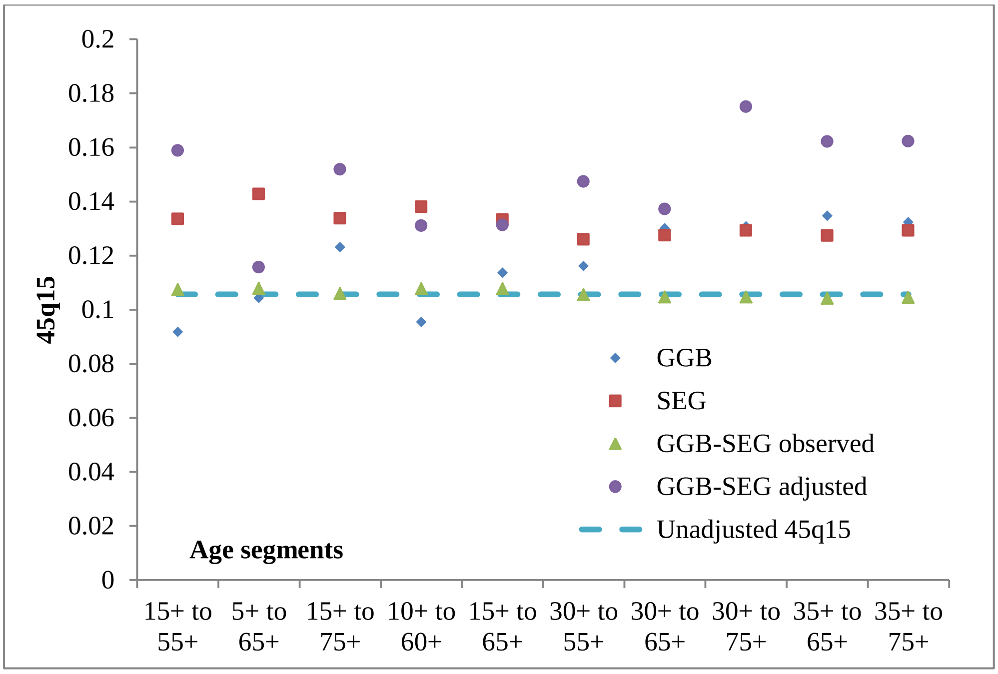
FIGURE 7. 8: Scatter plot of probabilities of dying 45q15 by methods and selected age segments for female population rural coastal area Suriname, 2004-2012



Source: Own elaboration based on data GBS and CBB, 2004-2012

For the urban coastal, rural coastal and rural interior area the age segments 10+ to 60, 30+to 55+ and 30+ to 75+ presents the greatest difference of $_{45}q_{15}$ between the methods adopted. For the urban coastal area and the rural interior area the unadjusted $_{45}q_{15}$ are nearly the same as the $_{45}q_{15}$ for the GGB-SEG observed adjusted values for all the age segments.

FIGURE 7. 9: Scatter plot of probabilities of dying 45q15 by age segments and methods for female population rural interior area Suriname, 2004-2012



Source: Data GBS and CBB, 2004-2012

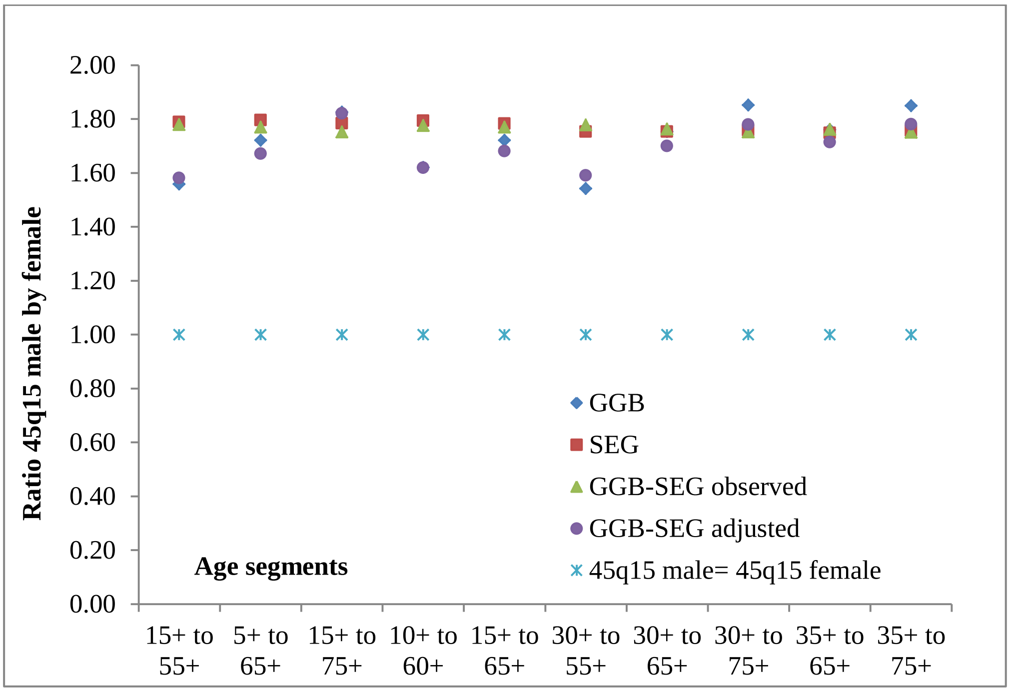
7.3 Discussion regional and sex differences in probability of dying 45q15 for Suriname and its main regions, 2004-2012

The discussion of regional and sex differences of probabilities of dying between 15 and 60 years of age in Suriname makes it possible to understand in a better way the estimation results of mortality acquired by the different DDM´s and age segments in this chapter. As seen in chapter two there exists demographic, social, and economic differences between the three main regions of Suriname. The ratio of the ${}_{45}q_{15}$ male to female population is used in order to see the differences in mortality by region, sex, DDM´s and age segments. For Suriname the differences are seen by sex, DDM´s and age segments. The unity of the ratio of ${}_{45}q_{15}$ male (***in the nominator***) by female population ***(in the denominator***) indicates that there is either for male or female disadvantage of mortality.

FIGURE 7.10 presents the result for Suriname, 2004-2012. As can be observe the ratios for Suriname vary between ***1.56*** and ***1.80,*** indicating the disadvantage of mortality for the male population in relation to female population. Certain age segment presents small differences of the ratio (e.g. age segments 15+ to 75+, 30 to 65+ and 35+ to 65+) within the methods, while other age segments presents bigger differences (e.g. age segment 5+ to 65+ and 30+ to 55+).

In case of Suriname we notice that the ratio ${}_{45}q_{15}$ male by female are far above the unity and thus also indicating that the distance between male and female mortality is huge.

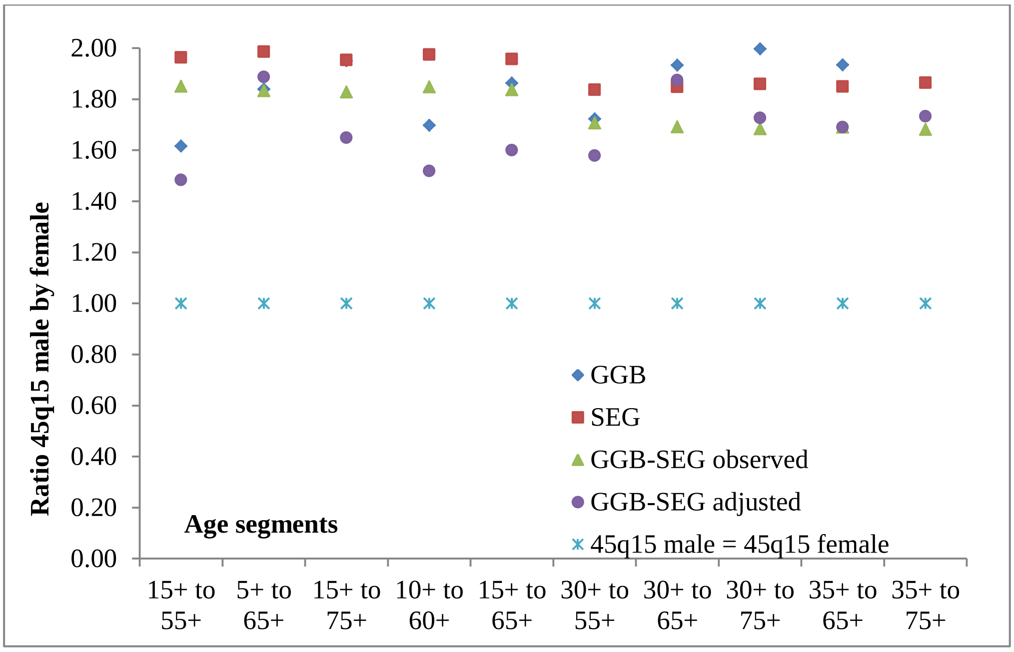
FIGURE 7. 10: Ratio probabilities of dying between 15 and 60 years, male by female population of Suriname, 2004-2012



Source: Data GBS and CBB, 2004-2012

Analysing the ratio $\frac{{}_{45}q_{15}^{MALE}}{{}_{45}q_{15}^{FEMALE}}$ for the main regions of Suriname the differences are clearly visible. For the urban coastal area the ratios are between ***1.52*** and **2.00** (FIGURE 7.11 ***on page 119***) whereby for some age segments the ratios are dispersed for the DDM´s. The SEG method produces for most of the age segments higher ratios and for other age segments the GGB has higher ones. The ratio of ***2.00*** (GGB by age segments 35+ to 75+) means, the probability of dying between 15 and 60 years of age for male is twice the probability of dying between 15 and 60 years of age for female population. In the urban coastal area the GGB-SEG adjusted has the lowest ratios for some age segments.

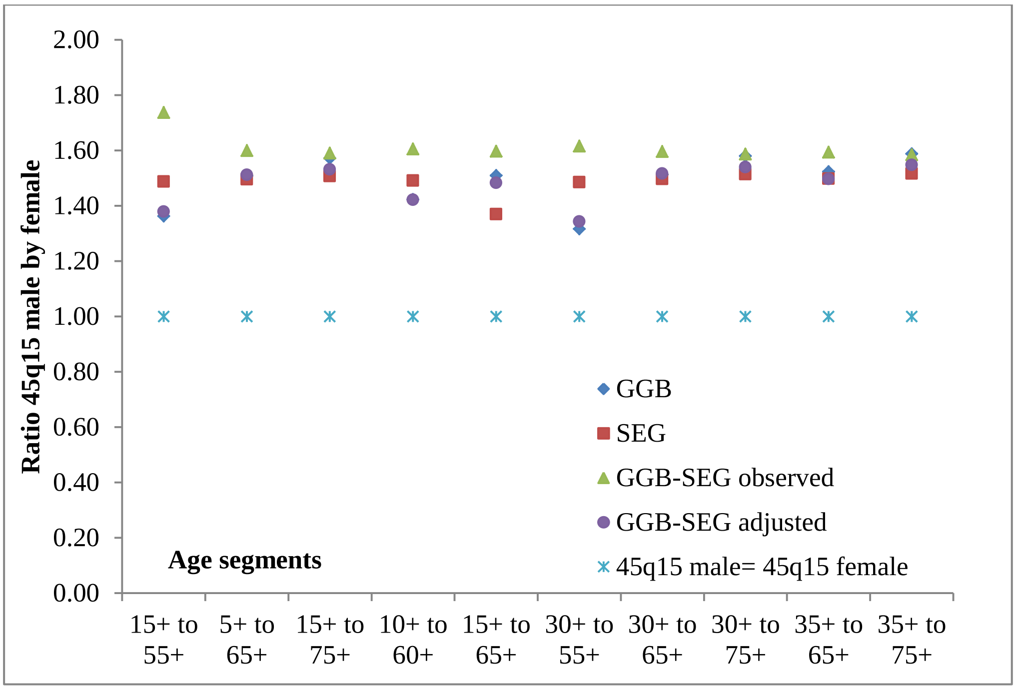
FIGURE 7. 11: Ratio probabilities of dying between 15 and 60 years, male by female population urban coastal area Suriname, 2004-2012



Source: Own elaboration based on data GBS and CBB, 2004-2012

Considering the results of the rural coastal area (FIGURE 7.12) we observe that the ratios vary between ***1.32*** and ***1.62*** and thus revealing that the gap between male and female mortality in this region is smaller than in the urban coastal area. Furthermore, the rural coastal area presents just as for the country ratios which are less dispersed between methods for a specific age segment. In the rural coastal area the GGB-SEG adjusted presents the lowest ratios for age segments with peak for the methods adopted. The SEG method produces the highest ratios in the rural coastal area for age segments with peak migration. Hence, these results confirm also the differences between the methods adopted.

FIGURE 7. 12: Ratio probabilities of dying between 15 and 60 years, male by female population rural coastal area of Suriname, 2004-2012



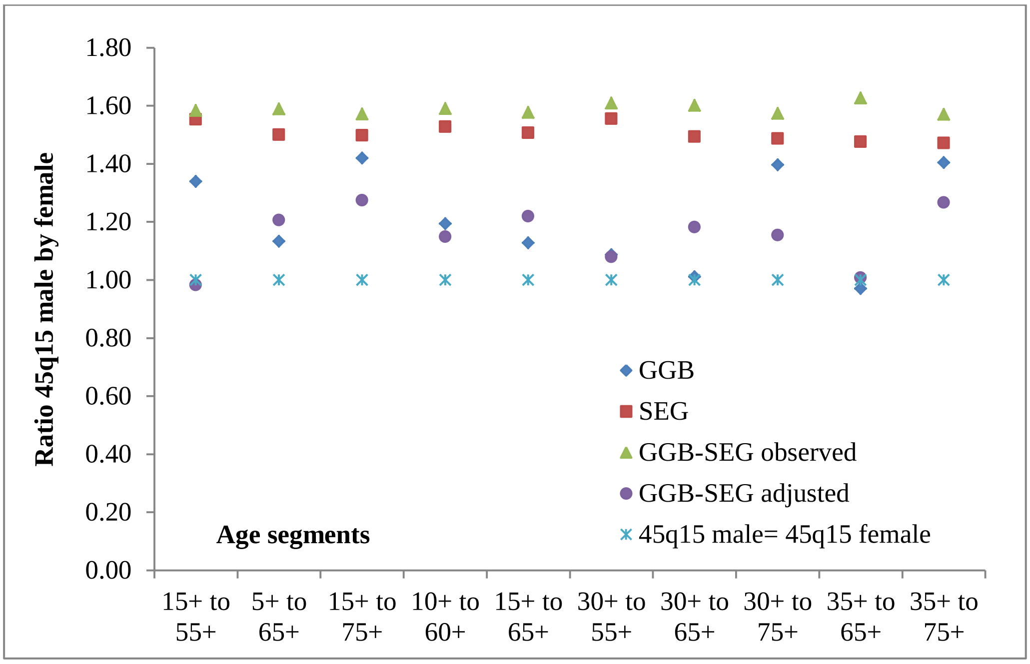
Source: Data GBS and CBB, 2004-2012

The rural interior area of Suriname has ratios between **0.97** and ***1.63*** and where by most of the ratios is less than ***1.5*** **(**FIGURE 7.13 ***on page 121*****)**. The GGB and GGB-SEG ***adjusted*** produce the lowest ratios compared to the SEG and the GGB-SEG observed ratios. The values of the ratios below the unity indicate that the ${}_{45}q_{15}$ for female is higher than those of the male in the rural interior area. Possible explanation of this result may be probably due to more out migration of the male population than the female population from the rural interior area, besides the small scale characteristic of this area. The result of ***0.97*** (GGB) and ***0.98*** (GGB-SEG adjusted) are for age segment 35+ to 65+ and 15+ to 55+, respectively. The GGB-SEG observed has the highest ratios of the ${}_{45}q_{15}$ male by female population in the rural interior area. However, the highest ratio (***1.63***) in the rural interior area is still below the highest one (***2.00***) in the urban coastal area and the highest one (***1.80***) for Suriname.

It is also important to mention that the rural interior area presents the highest ***"width"***[42](***0.66***) of the ratio $\frac{{}_{45}q_{15}^{MALE}}{{}_{45}q_{15}^{FEMALE}}$ out of all the three regions and the country. The "***width"*** of ***0.66*** indicates that the gap of mortality between man and women vary a lot by the DDM´s and age segment for the rural interior area. The rural interior area is the only area where the results of the ratio reveal a disadvantage for female mortality for some age segments. This disadvantage for female in reality may be probably ***"false".***

In this case "***false"*** means that in reality the women still have the advantage of mortality, however the small scale of the population in combination with the outmigration of male population result in ratio ${}_{45}q_{15}$ male by female population below the unity.

FIGURE 7. 13: Ratio probabilities of dying between 15 and 60 years, male by female population rural interior area Suriname, 2004-2012



Source: Own elaboration based on data GBS and CBB

Furthermore, we observe that the much dispersed ratios ${}_{45}q_{15}$ male by female population by age segments in the rural interior area compared to the urban coastal area and rural coastal area reflects that:

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[42] The width is the difference between the lowest and highest ratio male by female mortality in every region

- The different assumptions of the DDM´s are violated in very different levels in the rural interior area;
- The results of the GGB-SEG ***adjusted*** and the GGB-SEG ***observed adjusted*** are huge, indicating the presence of more data errors in the rural interior area;
- The differences between the results by age segments is very diverse in the rural interior area;

8. CONCLUSIONS

Suriname as a developing country makes an effort to apply since 2015 the principle of ***health in all policies*** (HiAP) proposed by the WHO and the Pan American Health Organization-PAHO[43]. Therefore, the estimation of adult mortality based on good population and death count data is of great importance. A decent functioning registration system of births and deaths is a solid base for the production of good quality mortality data. Furthermore, the conduction of a good Census is also relevant. Consequently, in this dissertation, the primary objective is the evaluation of the data quality of the living and death counts for the period 2004-2012. The data quality of the population was investigated using Whipple´s Index (GBS, 2004 and 2012), Coale and Kisker (1986) measure. The index on the concentration of single ages for Census 2004 and 2012 is considered to be good for the country and its main regions. For the death count data, the consideration of the quality of the data is reasonable to good for Suriname and its main regions for the period 2004-2012.

The second objective of this dissertation is the determination of the completeness of death counts registration concerning the population in Suriname and its main regions in the most recent period 2004-2012 by the use of the DDM´s. The General Growth Balance (Hill,1987), Synthetic Extinct Generation (Benneth and Horiuchi,1981), and the Hybrid GGB-SEG (Hill, You and Choi, 2004) have produced different results by different age segments for the completeness of death recording about the population in Suriname and its main regions. The variation is estimates by the three alternative methods is expected and discussed in the literature.

Since Suriname is a country that has the characteristics of international and internal migration, the validation for the application of the DDM´s needs some discussion. The assumption of no migration for the use of the DDM´s in this study is partially solved by the use of age segments ***with*** and ***without*** peak migration. It is clear that the two clusters of age segments point out different results regarding the parameters, the diagnostic plots and the probability of dying between 15 and 60 years. Each DDM also produces different results, by age segments and sex, whereby some methods are depending on the region over or underestimate mortality.

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[43] https://www.dur.ac.uk/public.health (accessed, 03 of January 2016)

Another aspect of the discussion of the validation of the application of the DDM´s to Suriname is concerning the pattern of migration by sex. This fact results in sex differences relating the violation of the migration assumption. Another aspect is regarding the effect of migration on small scale population. The rural coastal area and the urban coastal area present in another way the impact of internal migration on the results of the parameters compared to the rural interior area.

The outcomes of the ***rural interior area*** thus reflect the effect of out-migration on the results through ***1)*** the smallest ${}_{45}q_{15}$ for male population within the application of the DDM´s, ***2)*** the disadvantage of female mortality and smaller ratios of male by female probability of dying between 15 and 60 years, and ***3)*** the high values (***about 1.36 to 1.42***) of completeness of death recording relative to the population by using the GGB method for age segment with high peak migration.

The four parameters of the GGB method (inclination (***K***), intercept, completeness of death recording relative to the population (***C=1/K***) and census coverage change) are determined for age segments ***including*** and ***excluding*** a high proportion of peak migration by sex and for Suriname and its main regions. The results for Suriname and its main regions show clearly the difference by sex, between the age segments ***including*** and ***excluding*** a high proportion of peak migration and by DDM´s.

The results by the SEG method reflect the violation of the migration assumption for all the main regions and Suriname. The urban coastal area and rural coastal area present similar pattern on the SEG result. The rural interior area has a greater presence of age varying of the death and population and not the improvement of census coverage 2012 for nearly all the age segments. Thus, the rural interior area shows a different pattern of the SEG result. Moreover, the application of the GGB-SEG for male population of the urban coastal area displays the completeness of death recording concerning the population for nearly all age segments ***excluding*** a high proportion of peak migration and values below the unity for the rural coastal area and rural interior area.

In conclusion, the completeness of death recording regarding the population may produce for the same age segment using different method values below or above the unity. This reveals that the assumptions for the use of DDM´s are violated in various ways and that each method in combination with a specific age segments may violate more or less the assumptions.

According to Hill, You and Choi (2009), age varying of census coverage has little effect on the estimates of the SEG method but has a large impact on the GGB method and quite a significant effect on the Hybrid GGB-SEG method. The authors also argue that age-varying coverage of deaths and omission of deaths has a substantial impact on the observed and all adjusted values. In the case of the rural interior area and rural coastal area, age-varying of deaths is more probable to occur due to the small scale of the population. Age misreporting of the population and death is more likely to occur in the rural interior area and the rural coastal area. In the study of Hill, You and Choi (2009) age misreporting together with omission of deaths and change in census coverage, results in substantial errors for the adjusted estimates.

In Suriname, all the three main regions suffer from out-migration and or in-migration. However, the rural interior area has an additional characteristic that is it has the smallest population, followed by the rural coastal area. The population by sex, in the rural coastal and rural interior area, result thus in much smaller populations and death count data. Overestimation of mortality occurs by the application of the SEG method in case of emigration or outmigration in combination with census coverage change and age misreporting of the census.

One of the achievements in this study is to show that the no-migration assumption can be solved by using age segments ***without*** a high proportion of peak migration and that the results are more acceptable, due to the migration characteristic of the country. The remaining data errors are considered to be a set of errors that may affect the results depending on the sensitivity of the adopted DDM´s.

The GGB plots using age range 5+ to 65+ show for Suriname, urban coastal area for male and female population and rural coastal area male a certain degree of goodness of fit. For the female population of the rural coastal area, the male and female population of the rural interior area the GGB-SEG using age segment 5+ to 65+ presents plots that detect greater violation of the assumption of the DDM´s compared to the other areas by sex.

To diminish the effect of migration on the rural interior area (male and female population) and the rural coastal area (female population) the diagnostic plots GGB-SEG using age segment30+ to 65+ are presented. These exercises show clearly that the diagnostic plot GGB-SEG using age segment 30+ to 65+ eliminate at least one violation of assumption of the DDM´s (***no-migration***). The diagnostic plot GGB-SEG using age segment 30+ to 65+ for the male population of the rural interior area reports still the presence of data error, which may be the age varying of census and death count data and age misreporting of census data and maybe death omission. Thus, the use of diagnostic plots ***with*** and ***without*** peak migration is also a way to verify the violation of the methods.

The diagnostic plots of the SEG and the GGB-SEG for selected age segments also reveal the breach of the assumption of the DDM´s. For male and female population of Suriname, both methods present some consistency of the curve; however, for female population the constancy of the curve is more than for male. Completeness of death recording $c(a)$ in Suriname is below the unity in most cases for the young adult ages depending on the choice of the selected age segment of GGB-SEG.

For the main regions the results of $c(a)$ are in some way different than the results applying SEG and GGB-SEG on country level. The rural coastal area, for example, reveals applying SEG for female and male population for young and mature adults values of c(a) above the unity. However, for the male and female population of the rural interior area for all the ages the values of $c(a)$ are below the unity, applying SEG.

These differing results of $c(a)$ by region and in some cases by sex indicate once again that the assumption of the DDM´s is violated in different ways. In other words, the combination and level of data error may not be the same in each region and by sex. The fact that the three regions are regarding population of different small quantities may in some way also interfere in the violation of the assumption 47.

Another important objective of this dissertation is the estimation of adult mortality for Suriname and its main regions through the calculation of the probability of dying between 15 and 60 years ($_{45}q_{15}$) for the male and female population. The analyses reveal that the minimum/maximum values $_{45}q_{15}$ of the age segments with peak migration are lower than those age segments without peak migration. For the main regions, the same situation also occurs. The unadjusted probabilities of dying between 15 and 60 years are for Suriname and its main regions in some cases higher or lower than the adjusted ones, which depend on the DDM´s applied and the age groups. In some cases also the unadjusted probabilities of dying between 15 and 60 years are close to the adjusted or observed one using the GGB-SEG method. This is the case for male and female population of Suriname and it indicates small data errors or in other words minimum violation of the method applied by the specific age segment.

Remarkable is that the GGB-SEG method for all age segments in the urban coastal area produce the highest (between ***0.2509*** and ***0.2528***) $_{15}q_{45}$ for the male population. On the other hand, the lowest $_{45}q_{15}$ for the male population are in the rural interior area produced by GGB method, age segments with peak migration and they are in the range of female $_{45}q_{15}$ on country level.

The differences in the probability of dying between 15 and 60 years for the male and female population ***<u>between the methods adopted</u>*** are higher in the rural interior area, compared to the urban coastal and rural coastal area. The SEG and GGB-SEG adjusted has values of $_{45}q_{15}$ close to each other for age segments with a high proportion of peak migration for female and male population of Suriname. Moreover, the GGB has lower values of $_{45}q_{15}$ for the age segments with a high proportion of migration compared to the SEG and GGB-SEG adjusted for male and female population of the country. For age segments ***without*** a significant part of peak migration the $_{45}q_{15}$ are greater than those for the age segments ***with*** a high proportion of peak migration applying GGB method for Suriname and the main regions.

It is interesting to observe that depending on the DDM´s applied by age segments, the results of the male and female population of the $_{45}q_{15}$ for Suriname are close to the $_{45}q_{15}$ of some states in Brazil (e.g. Minas Gerais, Mato Grosso do Sul, Pernambuco, Para, Amazone, Ceara, Roraima). In the mortality study of Brazil, Agostinho (2009) determined for all the 27 Federative Unities of Brazil the probability of dying between 15 and 60 years applying DDM´s for 2000.

The sex differences by DDM´s in Suriname reveal that the ratio of the probability of dying between 15 and 60 years male by female is an advantage for the female population, as is observed in several other countries such as Brazil and Mozambique (Agostinho 2009; Alberto, 2013). Concerning the urban coastal area and the rural coastal area, it is also the case. However, the difference by the method is in some instances smaller than in others. Of interest is the result of the rural interior area. The result presents for age segments in two cases the advantage of mortality for the male population (GGB-SEG adjusted by age segment 15+ to 55+ and GGB age segment 35+ to 65+). Certainly these outcomes can be committed to the violation of the migration assumption and the degree of existence of other data errors besides the existence of a small population.

The different results of the parameters of the DDM´s, the diagnostic plots, different ${}_{45}q_{15}$ by region and sex are probably provident of the difference in socio-economic and demographic characteristics in Suriname. Results of the urban coastal area and Suriname are more similar, which can be attributed to the fact that 66% of the population live in the urban coastal area, and this area is more developed part of the country. The results of the rural interior area may be considered being more different in comparison to the outcome of the urban coastal and rural coastal area.

Finally, it is important to mention that in this study, the life expectancy for Suriname and its main regions were not calculated because the evaluation of the quality of the death counts data of children below five years was not performed. To produce correct estimates of infant and child mortality evaluation of the data quality of births and death count data is necessary. Only then it will be possible to calculate more precisely the life expectancy at birth. In all the parts of the mortality curve (child, adult, and elderly) it is important to execute data evaluation and correction of the data to estimate life expectancies.

Limitations and opportunities in this study

In this study, it was not possible to measure the degree of violation of the assumptions for the use of the different methods. However, it was possible to observe that violation of the methods occurs through the fact that the different methods give different results by age segments ***with*** and ***without*** peak migration. Furthermore, the population and death count data of Suriname and its main regions can be considered reasonable to good, and thus, the violation of the assumptions can be confirmed with a greater certainty.

Moreover, the diagnostic plots are also a very helpful tool to analyse in combination with the results of the parameters of the GGB, SEG and Hybrid GGB-SEG method the violation of the assumptions of the DDM´s. The diagnostic plots also help to identify the existence of data errors. Nevertheless, the level of the error cannot be determined in practice. In this study, it was also not possible to determinate the degree of the data errors.

In simulation exercises, it is possible to set up a value of data error and see what the effects are on the parameters, diagnostic plots and the probabilities of dying between 15 and 60 years (Hill, You and Choi, 2009; Murray *et al*., 2010). According to Murray *et al.* (2010), the DDM´s have at least three limitations. First, a broad range of variants of these methods has been applied in practice with little scientific literature to guide their selection. Second, the methods have not been extensively validated in real population conditions where a violation of the assumptions of the methods most certainly occurs. Lastly, DDM´s do not generate uncertainty intervals.

In the study of Suriname and its main regions, the first limitation mentioned by Murray *et al.* (2010) is visible through the fact that the author chooses **all** the three methods by selected age segments in order to calculate the parameters and the probability of dying between 15 years and 60 years. Nevertheless, this study considering the second limitation described by Murray *et al.* (2010) show that*:* the application of DDM´s is an opportunity to demonstrate the validation of the method in case the violation of at least the no-migration assumption occurs and that it can be solved partially. The solution is given by the use of age segments ***including*** and e***xcluding*** a high proportion of migration. Considering the third limitation proposed by Murray *et al.* (2010) the observation can be made that further studies in small scale population countries with relatively good data need to be conducted with respect to:

- ${}_{45}q_{15}$ for age segments ***excluding*** and ***including*** a high proportion of migration for the three main DDM´s.
- the completeness of death reporting concerning the population for the clusters of age segments ***with*** and ***without*** peak migration of the GGB, SEG and GGB-SEG method
- the values of the slope K of the GGB method

For the other data errors, the opportunity still exists to continue looking for manners to identify the errors separately in the result analysis.

ANNEX A- ANTECEDENTS SURINAME

TABLE A 1: Ten main causes of death in Suriname 2004-2011

	Annul number of deaths by main causes 2004-2011									
Death Causes	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**mean percentage BOG**	**mean percentage CBB**
Cardiovascular Diseases and Cero vascular Diseases	862	911	854	848	819	813	870	767	***0.2795***	***0.2508***
Accidents and Violence	303	351	330	364	398	422	374	374	***0.1205***	***0.1084***
Malign Neoplasms	292	319	334	310	376	351	376	390	***0.1136***	***0.1021***
Perinatal Diseases	244	252	246	251	233	262	292	236	***0.0834***	***0.0749***
Diabetes Mellitus	133	171	155	189	171	174	122	251	***0.0566***	***0.0507***
Acute Respiratory Infections (ARI)	64	71	67	103	79	87	113	113	***0.0287***	***0.0258***
Diseases of the urinary System	53	52	55	70	58	89	69	73	***0.0215***	***0.0193***
H.I.V/AIDS	152	181	129	142	120	106	119	105	***0.0438***	***0.0392***
Intestinal Infections	95									
Chronic Diseases of the lower Respiratory Organs	43	44	52	45	54	41	0	38		
Total number of deaths (CBB)	**3319**	**3392**	**3247**	**3374**	**3357**	**3293**	**3484**	**3441**		
Total number of deaths (BOG) with DEATH CERTIFICATE	**2806**	**3091**	**2852**	**3010**	**3116**	**3034**	**3228**	**3036**		
Ratio Death Data CBB/BOG	***1.1828***	***1.0974***	***1.1385***	***1.1209***	***1.0773***	***1.0854***	***1.0793***	***1.1334***		

Source: data CBB , GBS and BOG

TABLE A 2: Lifetime fertility by ethnic groups and age groups in Suriname Census 2004

Age groups	Maroons	Creole	Javanese	Mix	Others	Unknown
12-19	0.4	0.2	0.1	0.1	0.3	0.5
20-24	1.3	0.6	0.6	0.6	0.9	1.0
25-29	2.4	1.1	1.2	1.2	1.6	1.3
30-34	3.6	1.9	1.9	1.8	2.2	3.2
35-39	4.8	2.4	2.3	2.3	2.9	3.5
40-44	5.5	2.7	2.6	2.6	3.1	3.8
45-49	5.8	3.1	3.2	2.8	3.5	4.9
50-54	6.0	3.3	3.5	2.8	3.8	4.8
55-59	6.2	3.6	4.4	3.2	3.6	4.3
60-64	5.7	3.9	4.1	3.2	3.7	3.2
12-64	**2.8**	**1.8**	**2.0**	**1.4**	**2.1**	**1.9**

Source: GBS, Census data 2004

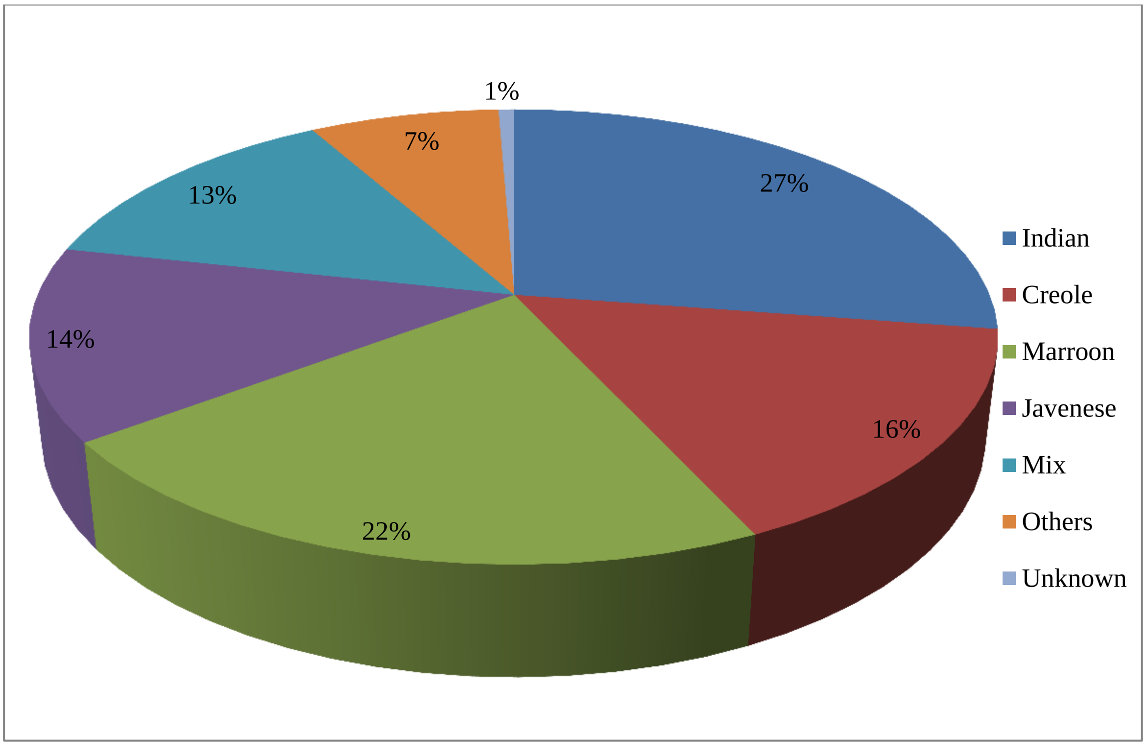
TABLE A 3: Life time fertility by ethnic groups and age groups in Census 2012

Age groups	Maroons	Creole	Indian	Javanese	Mix
15-19	0.2	0.1	0.1	0.1	0.1
20-24	1.1	0.6	0.4	0.6	0.6
25-29	2.2	1.2	1.0	1.2	1.2
30-34	3.1	1.7	1.7	1.8	1.8
35-39	4.1	2.2	2.2	2.2	2.3
40-44	4.5	2.5	2.3	2.4	2.5
45-49	5.1	2.7	2.6	2.6	2.6
50-54	5.4	3.0	2.9	2.8	2.6
55-59	5.5	3.0	3.3	3.3	2.8
60-64	5.9	3.4	3.8	3.9	2.9
15-64	**2.9**	**1.9**	**1.9**	**2.0**	**1.5**

Source: GBS, Census data 2004

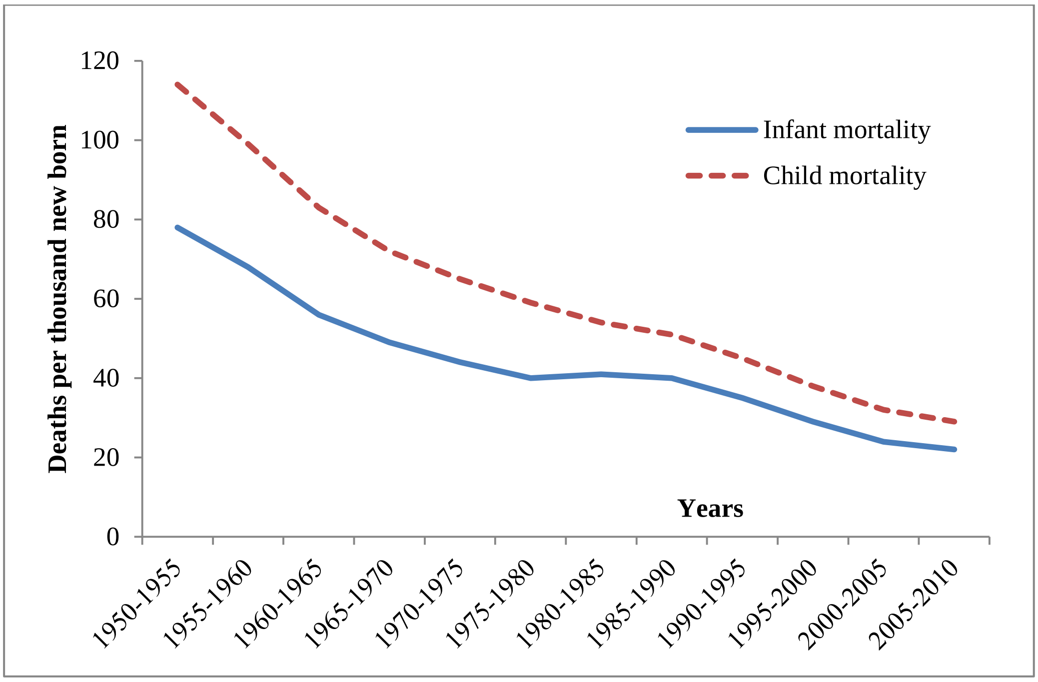
FIGURES A

FIGURE A 1: Population Census 2012 in Suriname by ethnic groups



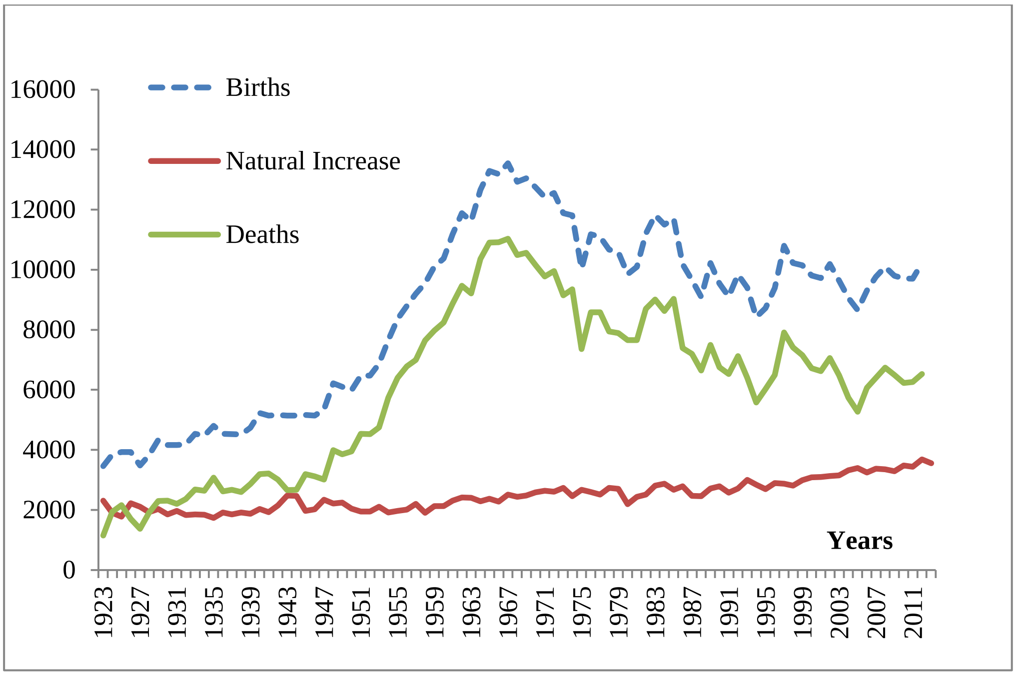
Source: Data GBS, Census 2012

FIGURE A 2: Infant and child mortality in Suriname 1950-2010



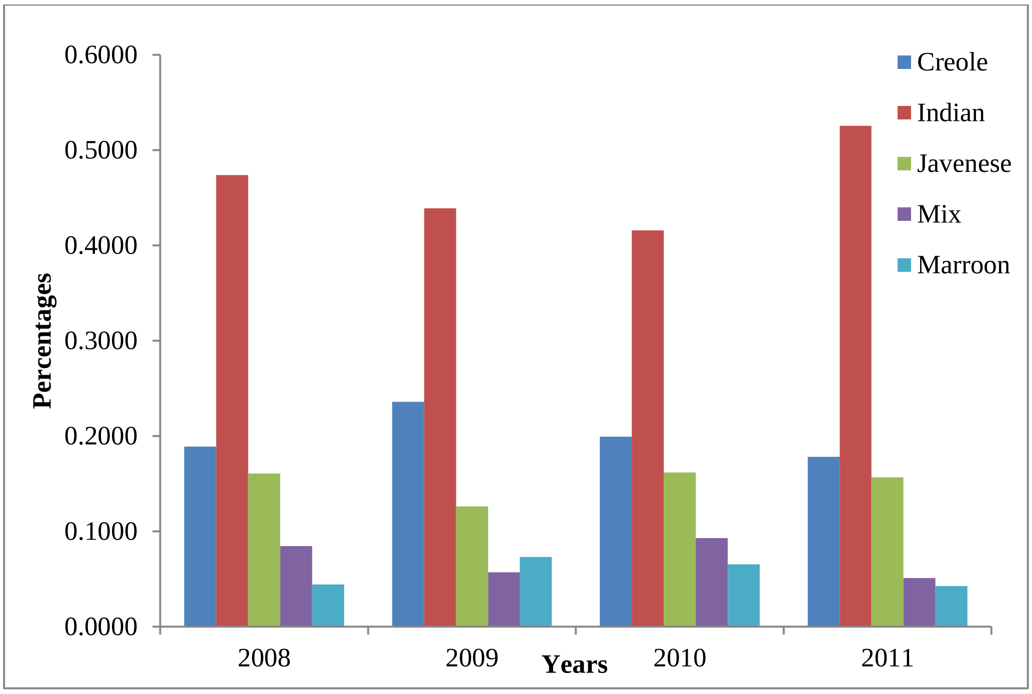
Source: Data United Nations, World Population Prospects, 2012

FIGURE A 3: Absolute number of births, deaths and natural increase of Suriname from 1923-2013



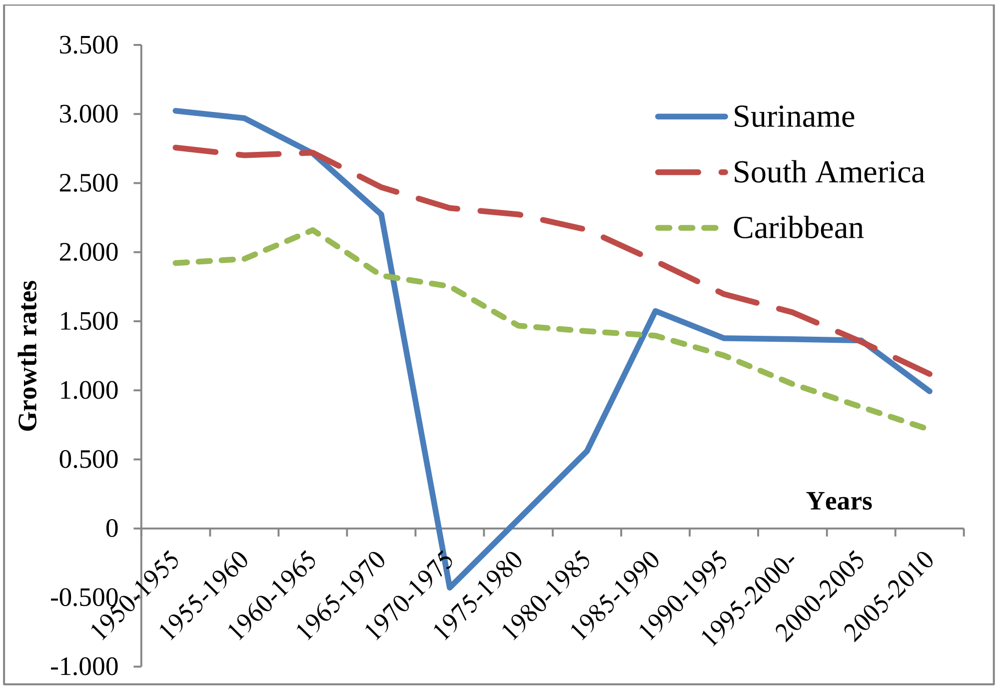
Source: Data CBB and GBS

FIGURE A 4: Ethnic groups in Suriname with the highest mortality due to cardio vascular disease, 2004-2011



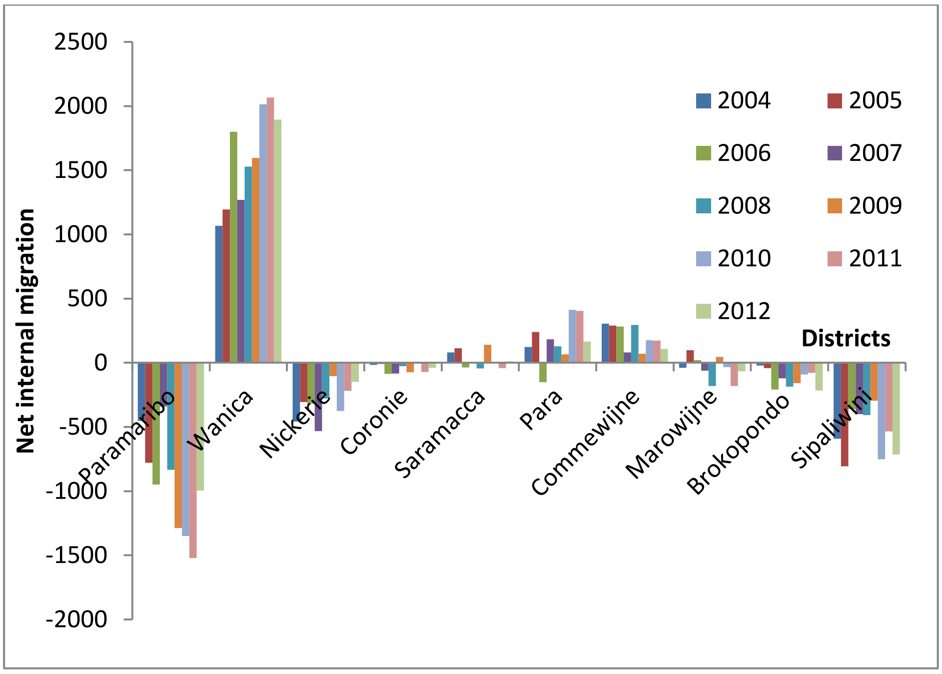
Source: Data BOG

FIGURE A 5: Population growth rates of Suriname, South America and the Caribbean 1950-2010



Source: Data World Population Prospects 2012, UN

FIGURE A 6: Net internal migration for both sexes by districts in Suriname, 2004-2012



Source: Census data 2012

ANNEX B- RESULTS POPULATION AND DEATH DATA

TABLE B 1: Coale and Kisker (1986) measure for selected countries, male and female population 2012

		MALE	POPULATION	
COUTRIES	**P95+/P70+**	**P80+/P60+**	**P90+/P60+**	**P70+/P60+**
Aruba	0.0018	0.0902	0.0068	0.3912
Curacao	0.0090	0.1367	0.0162	0.4438
Cuba	0.0137	0.1570	0.0257	0.4809
Jamaica	0.0110	0.1807	0.0256	0.4967
Netherlands	0.0042	0.1313	0.0117	0.4392
France	0.0074	0.1816	0.0155	0.5057
Sweden	0.0078	0.1696	0.0214	0.4644
Italy	0.0071	0.1723	0.0171	0.5276
		FEMALE	**POPULATION**	
COUTRIES	**P95+/P70+**	**P80+/P60+**	**P90+/P60+**	**P70+/P60+**
Aruba	0.0063	0.1252	0.0214	0.4644
Curacao	0.0142	0.1723	0.0171	0.5276
Cuba	0.0209	0.1969	0.0388	0.5231
Jamaica	0.0206	0.2177	0.0417	0.5489
Netherlands	0.0140	0.2158	0.0338	0.5219
France	0.0229	0.2726	0.0395	0.5910
Sweden	0.0203	0.2481	0.0476	0.5388
Italy	0.0181	0.2517	0.0377	0.5970

Source : Data World Population Prospects 2012

TABLE B 2: Reference death data (Coale & Kisker, 1986) male population for selected countries 1999-2001, 2000-2005 and 2005-2010

Period	Countries	D95+/D70+	D80+/D60+	D90+/D60+	D70+/D60+
2000-2005	***Aruba***	***0.0134***	***0.3473***	***0.0571***	***0.7098***
2005-2010	***Aruba***	***0.0115***	***0.3308***	***0.0524***	***0.7114***
2000-2005	**Cuba**	0.0505	0.4588	0.1274	0.7753
2005-2010	**Cuba**	0.0544	0.4555	0.1301	0.7783
2000-2005	***Curaçao***	***0.0357***	***0.3756***	***0.0933***	***0.7385***
2005-2010	***Curaçao***	***0.0392***	***0.3943***	***0.0903***	***0.7352***
2000-2005	**Jamaica**	0.0407	0.4335	0.1089	0.7838
2005-2010	**Jamaica**	0.0439	0.4332	0.1165	0.7777
1999-2001	**Netherlands**		0.4680	0.1150	0.8170
2000-2005	**Netherlands**	0.0240	0.4240	0.0861	0.7963
2005-2010	**Netherlands**	0.0271	0.4578	0.0943	0.8005

Source: Period 1999-2001 for Netherlands (Agostinho and Queiroz, 2009); Period 2005-2010 (World Population prospects, 2012), based on own elaboration.

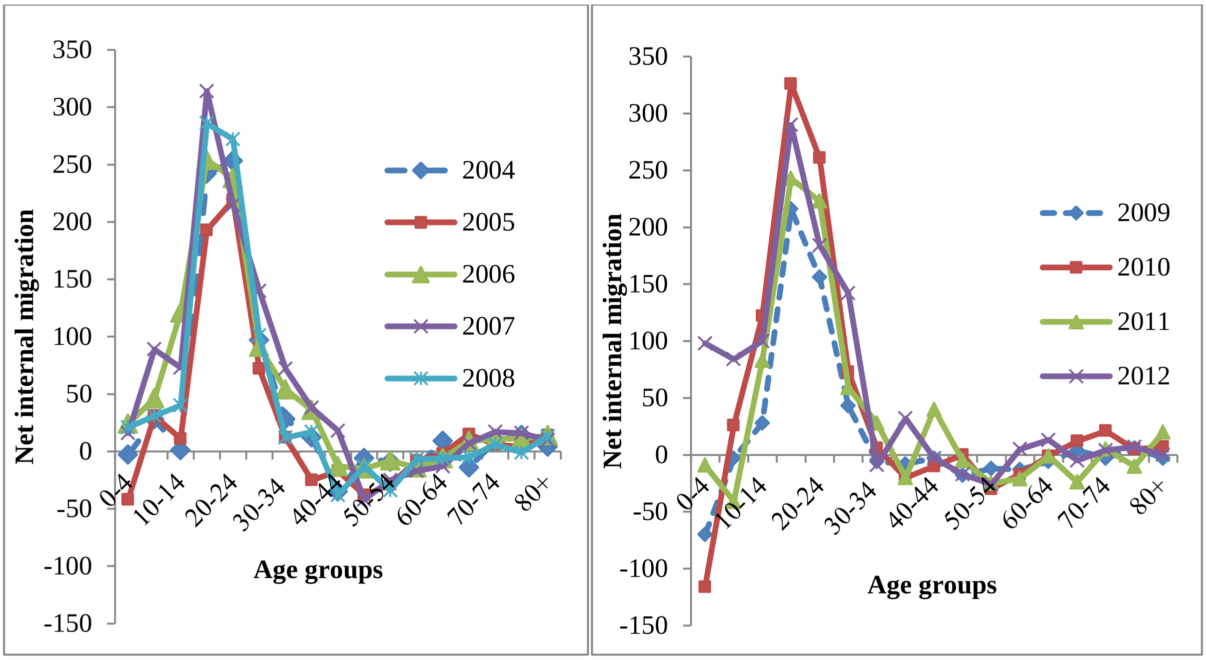
TABLE B 3: Reference death data (Coale & Kisker, 1986) female population for selected countries 1999-2001, 2000-2005 and 2005-2010

Period	Countries	D95+/D70+	D80+/D60+	D90+/D60+	D70+/D60+
2000-2005	***Aruba***	***0.0310***	***0.5036***	***0.1207***	***0.8002***
2005-2010	***Aruba***	***0.0375***	***0.4603***	***0.1258***	***0.8053***
2000-2005	**Cuba**	0.0684	0.5538	0.1774	0.8317
2005-2010	**Cuba**	0.0826	0.5664	0.1951	0.8392
2000-2005	***Curacao***	***0.0608***	***0.5080***	***0.1481***	***0.8173***
2005-2010	***Curacao***	***0.0656***	***0.5171***	***0.1621***	***0.8172***
2000-2005	**Jamaica**	0.0661	0.5237	0.1705	0.8380
2005-2010	**Jamaica**	0.0752	0.5452	0.1766	0.8503
1999-2001	**Netherlands**	**-**	0.5670	0.1720	0.8620
2000-2005	**Netherlands**	0.0750	0.6470	0.2247	0.8946
2005-2010	**Netherlands**	0.0871	0.6696	0.2397	0.8904

Source: Period 1999-2001 for Netherlands (Agostinho and Queiroz, 2009); Period 2005-2010 (World Population prospects, 2012), based on own elaboration

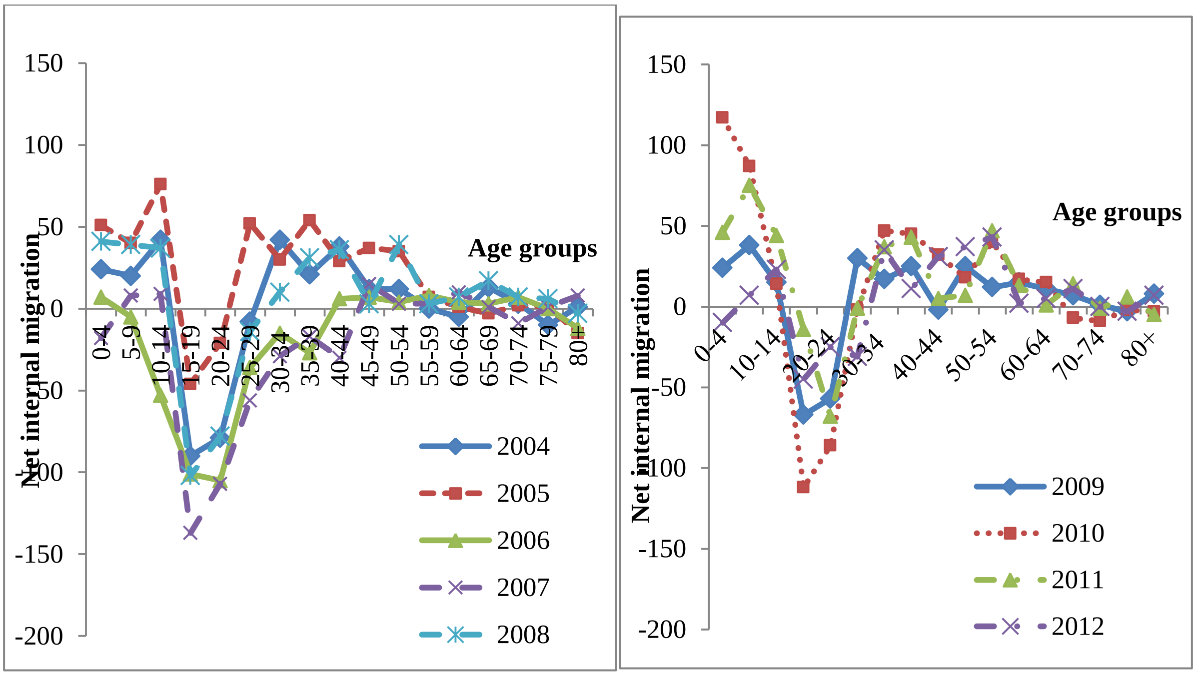
ANNEX B: RESULTS MIGRATION DATA

FIGURE B 1: Net internal migration for both sexes by age groups urban coastal area in Suriname, 2004 -2012



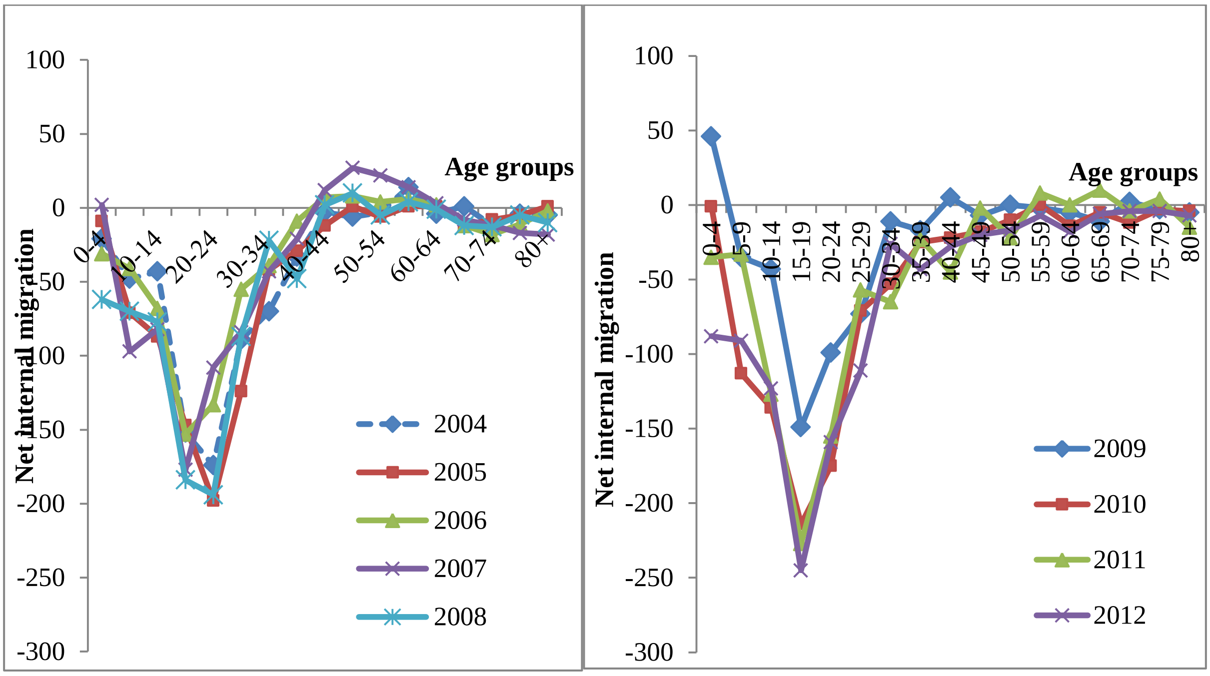
Source:Data CBB data

FIGURE B 2: Net internal migration both sexes by age groups rural coastal area Suriname, 2004-2012



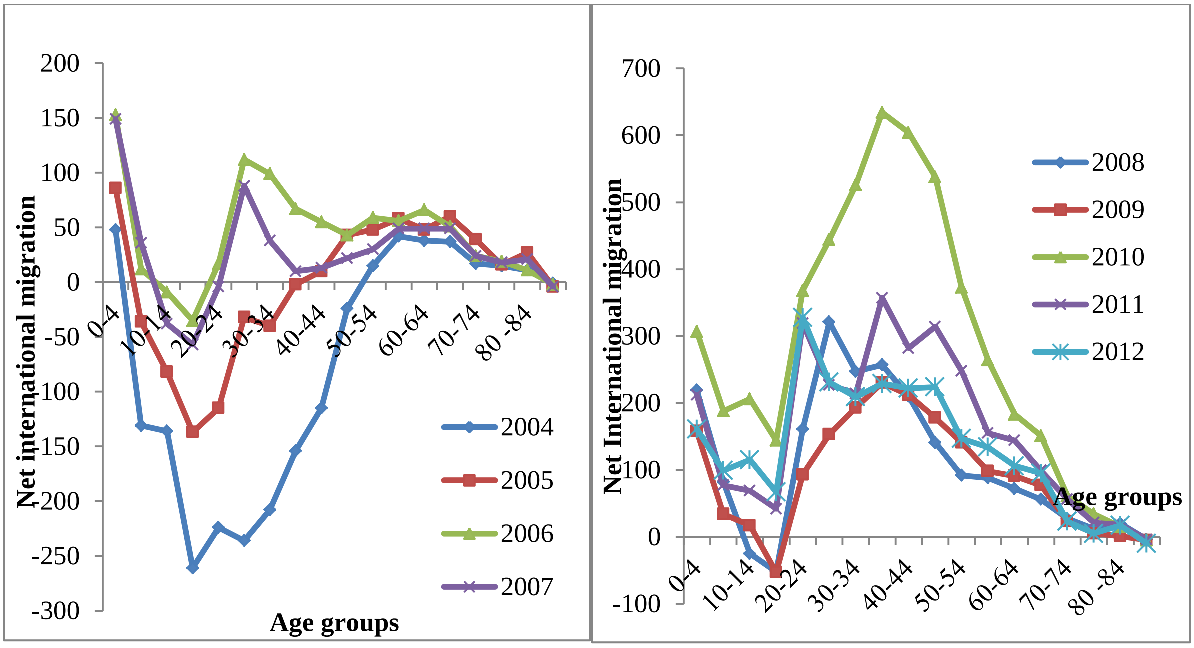
Source: Own elaboration with CBB data

FIGURE B 3: Net internal migration for both sexes by age groups rural interior area Suriname, 2004-2012



Source: CBB data

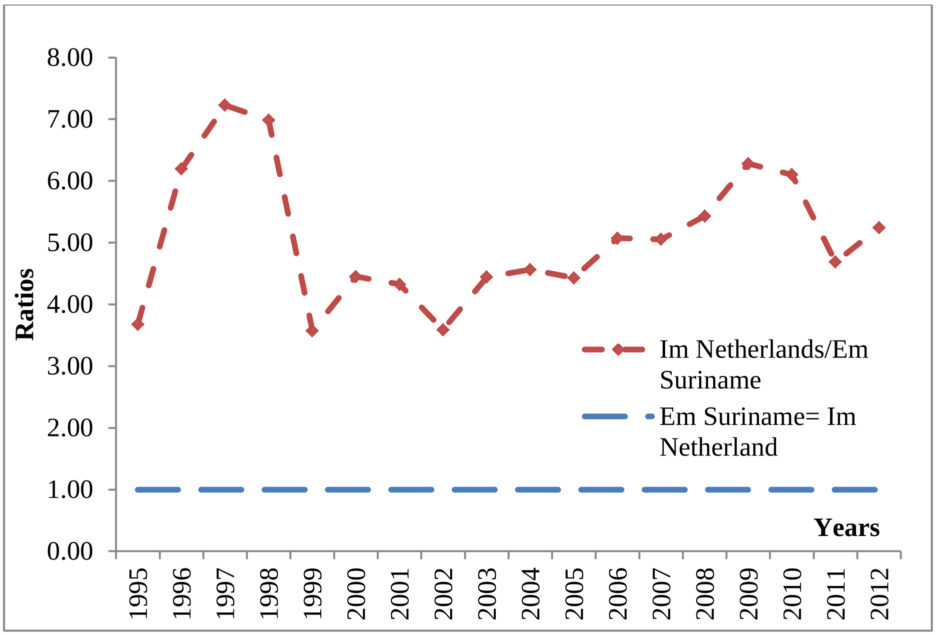
FIGURE B 4: Net international migration Suriname, both sexes by age groups 2004-2012



Source: CBB data

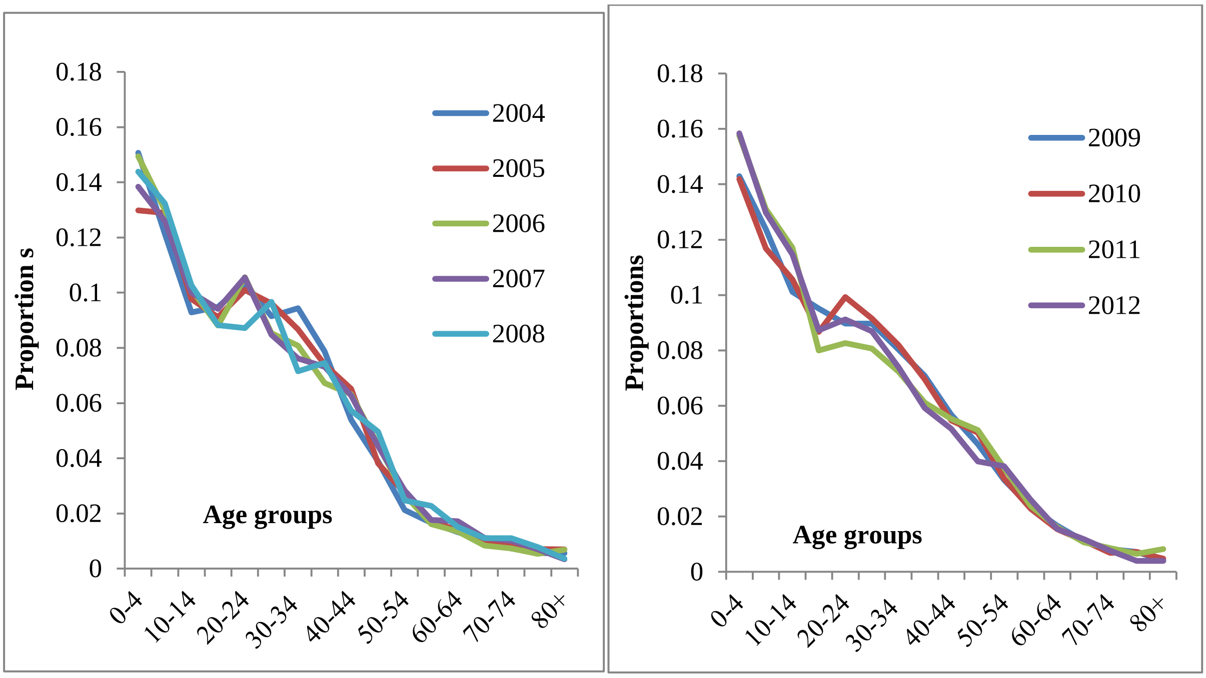
Note: The emigration data is from CBS (in the Netherlands) and the immigration data is from CBB (in Suriname)

FIGURE B 5: Ratio Immigration data CBS to Emigration data CBB 1995-2012



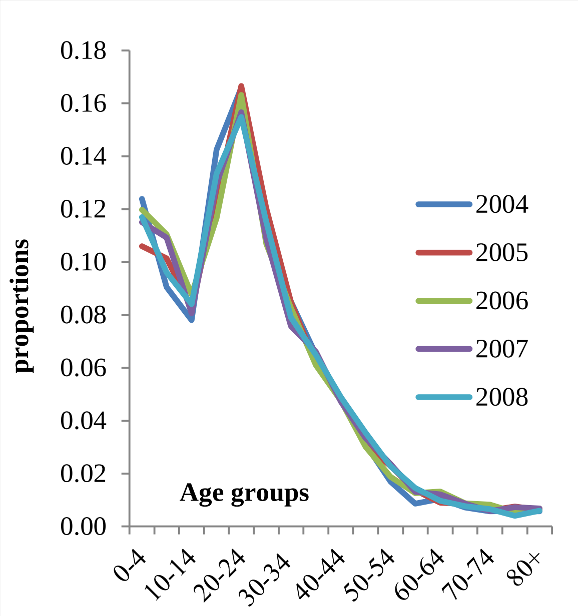
Source: Own elaboration with CBB and CBS data

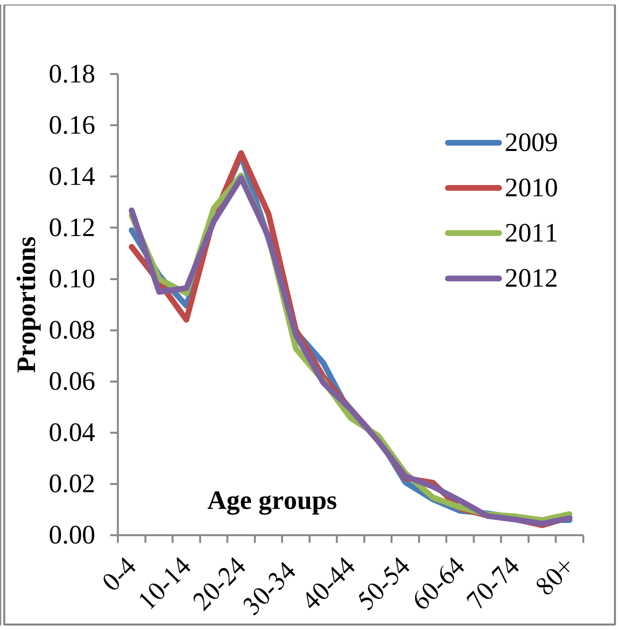
FIGURE B 6: Age pattern of internal migration male population in Suriname 2004-2012



Source: CBB data

FIGURE B 7: Age pattern internal migration female population in Suriname 2004-2012





Source: CBB data

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