

Simulate the Demographic Changes in Gaza Strip After the Last Three Wars by Using Statistical Physics

Muneer A. Sumour^{1,*}

M.M. Shabat^{2,}

¹Department of Physics, Faculty of Science Al-Aqsa University of Gaza, Gaza Strip

²Department of Physics, Faculty of Science Islamic University of Gaza, Gaza Strip, Palestine p, Palestine

Corresponding author*

e-mail address: ma.sumoor@alaqsa.edu.ps

<https://doi.org/10.33976/IUGNS.28.1/2020/06>

Abstract:

During the last period the Gaza Strip suffered a brutal war that has affected all aspects of life in Gaza Strip, especially the demographic and social harmonization, low level of birth rate and increased level of young people emigration.

Mortality and birth rates, emigration and retirement age, those factors play a major role in demographic changes in many countries. The level of birth rate decreased in the past century, first without a noticeable decrease of the fertility, moreover the level of human life expectancy increased, leading to a significant increase in population growth. In many countries the number of births has fallen and the human life expectancy increased. This study concentrates on measuring, analyzing and extrapolating of age structure in the Gaza Strip for next few decades, using the updated data available. A Fortran program was designed to simulate and analysis of statistical data, to examine the demographic change in the Gaza Strip and the expectation of Palestinian problems in the future. The study showed that the Palestinians life expectancy will increase, the fertility the Palestinians women will decrease, the fraction of young manpower will decrease. Therefore the study recommends to increase the retirement age to 65 years, and to develop a strategic plan to decrease the emigration of young people

Keywords:

Demographic change; birth rate; fertility rate; retirement age; Palestinian Territories; and emigration

1. Introduction:

About our planned simulation of Palestinian demography including wars, emigration and declining birth rate, most of all we need empirical data about Palestine. This paper studied birth rates, life expectancy, pensioners to workers ratio and retirement age in Palestine. Scientists in the sociophysics had tried to shed light on the labor market, to investigate the major factors that could decrease birth rates, we know that these factors might differ from one country to another[1-4]. Birth rates having been falling already a century ago in rich countries like France[1], and it will be difficult to ascribe a decay of births in Palestine to wars. The mortality function μ at middle age increases exponentially with age [4]:

$$\mu(a) \propto \exp(ba), \quad (1)$$

Thus

$$\mu = -d [\ln S(a)]/da, \quad (2)$$

where $S(a)$, the number of survivors from birth to age a , is assumed to follow a Gompertz law for adults:

$$\mu \propto b \exp[(a - X)b], \quad (3)$$

The Gompertz slope b is assumed to increase linearly with time from 0.06 in 1821 to 0.093 in 1971 and to stay constant thereafter, in contrast to Bomsdorf [6] and Azbel,[5] but in agreement with Yashin et al[7].; see also Wilmoth et al.[8] Instead, the characteristic age X was constant at 103 years until 1971 and then increased each year by 0.04 years to give a rising life expectancy.

Instead, we could try to check if our old formula [10] in the Fortran program in our Appendix, and we use numbers of births per woman equal to number of birth in formula:

$$\text{Number of birth} = 6.9 + (2.16.9) * (1 + \text{TANH}((\text{IYEAR} - 2012) / \text{CONST})) / 2 \quad (4)$$

The calendar year is t , and called $iyear$ in the Fortran program.

Migration is usually made by young people, not by old ones. Assuming a fraction ($-c$ in program) of people in the age interval of 6 to 40 years to emigrate, we could insert after loop 6 in our program loop 7.

In 2007 [10] we studied mortality, birth rates and retirement age which play a major role in demographic changes, and we find that Palestinians will have in future problems as the strongest age

cohorts are the above 60 year olds. Traditional wars may affect mostly young male soldiers, but in the Gaza strip they may instead kill civilians of all ages[2]. Assuming a killing fraction WAR independent of age in every calendar year, we could add loop 8, then 2012 is the year in which the birth rate decreased most. We take the emigration from Gaza as 5.1 per year and 1000 inhabitants, i.e. as $c = -0.0051$. (5.1 per 1000) inhabitants which mean that is equal $5.1/1000=0.0051$. And the war death per year since 1948 is $2000/2000000=0.001$.

Data And Simulation:

In our simulation, we use the Fortran program, the constants a In equations(1-3) is the age variable and d is adjusted to give a continuous slope in life expectancy vs. year for 1971. According to theoretical model shown in (Eqs.1-4) with the Palestinian statistical data, from Eq.(4) the birth rate is shown in Fig.1 to be in Gaza Strip in 1997 was 6.9 but in 2011- was about 4.5 and in 2015 4.1. Thus we use in figure 1 a birth rate of 6.9 in the distant past, 4.5 at the transition year 2012, and 2.1 in the distant future for different constants(6,10,15,20).

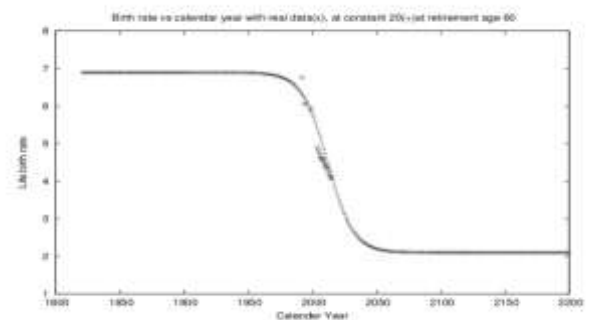
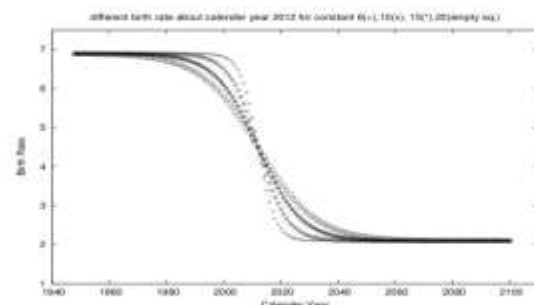


Fig. 1. Different birth rate vs. calendar year for different constant (6,10,15,20) which shows the birth rate will be about 2.1 in the distant future, giving an equilibrium of births and deaths.



Only very few countries have birth rates 1.3 (South Korea, Spain, ...). Most Arab countries have it above 2.1. Also Portugal, Italy, Greece and Cyprus have

Fig. 2. Different birth rate versus calendar year for transition year 12 with constant 10, x signs give real data for Gaza strip.

very low birth rates, while France has much higher rates. Gaza should follow France, not Italy.

Figure 2 shows us (with x for real data from the Gaza strip) the birth rate according to different years with constant 10 for example and compared with the real data of Gaza Strip.

The basic idea is that up to the year 1971 the improvement of medicine lead to increase of b in the Gompertz mortality law, variables b and x, while x stays at 103 years. After 1971, b remains at its last value 0.093 and instead the typical death year x increases every year above 103 years by $d = 0.15$ years. Then we need to put in the our code the statement:

`if(iyear.gt.1971) x=x0+d*(iyear-1971)`

Figure 3 shows us at $d=0.04$ the value of life expectancy varies smoothly around 1971 without a sharp change of slope in 1971.

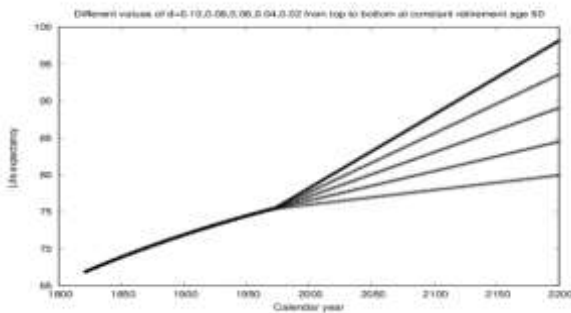


Fig. 3. Life expectancy vs. calendar year for constant retirement age 60 with constant 20 at different values of $d(0.02,0.04,.06,0.08,0.10)$.

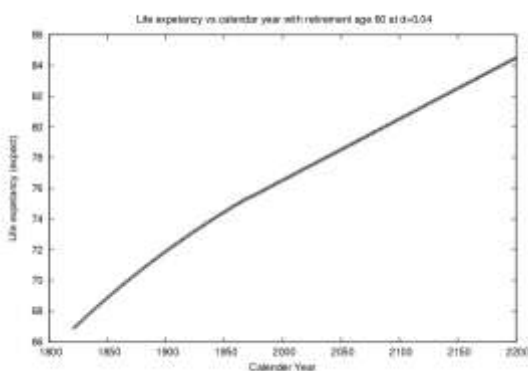


Fig. 4. Life expectancy vs. calendar year for retirement age 60 with constant 20 at $d=0.04$.

Figure 4 shows in the year 2200 Palestine may be where Japan is now Reality may differ from our predictions the further away the future is.

We investigate the effect of retirement age on the ratio of your labor to working-age people to Gaza Strip, based on enforced retirement for all governmental employees in Gaza Strip, most of the retirement age values are 50,55. Additionally I added the age values 60 and 65 to investigate the differences of retirement age on the ratio pensioners to workers, with workers from 22 years to retirement age as shown in Fig.5, at constant 20.

We see that from fig. 5 the higher retirement age is better for modern societies, even though the citizens of Russia dislike it.

If the retirement age is varied by the government, then life expectancies should not depend on this retirement age, pensioners to workers then depend on retirement age.

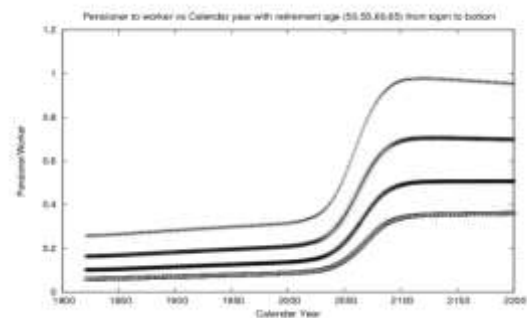


Fig. 5. Pensioner to worker versus calendar year for different retirement age (50,55,60,65) with constant 20.

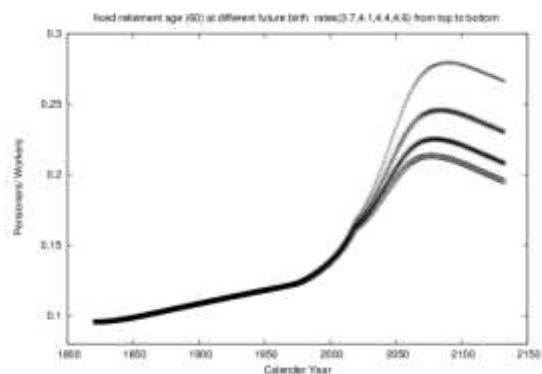


Fig. 6. pensioner to worker versus calendar year for different future birth rates (3.7,4.1,4.4,4.6) with constant retirement age 60 with constant 20.

In all simulations the ratio of pensioners to workers is defined by the age cohorts: Older than retirement age, and between 22 years and retirement age. In reality, of course, not everybody in the second group actually works. We got from the Paris newspaper Le Monde, October 3, 2018, the fraction of women and men which were employed in 2017:

Sweden: 79,8 % of women, 83.8 % of men, Italy: 52.5 % of women, 72.3 % of men, Eurozone: 65.4 % of women, 74.6 % of men (these are the 19 countries in the European Currency Union).

We replaced the value 2.1 in eq.(4) and all other figures by 3.7, 4.1, 4.4 and 4.6 in fig.6. Simulations show that the life expectancy does not change with changing the initial retirement age, because the life expectancy is based on biology, the retirement age is fixed by political decisions and influences the ratio of pensioners to workers. After the year 2020, we let now retirement age increase [9] by an amount proportional to the increase of the life expectancy, which may be politically easier and scientifically safer than arbitrary government decisions.

We let this proportionality factor vary between 0.3 and 0.9. Then the retirement age is no longer an independent variable but is a result of the simulation. Thus plots of retirement age versus calendar year and of life expectancy versus calendar year should show some similarity. In Fig.7 all curves overlap if the initial retirement age is subtracted: The biology does not change if the government changes the initial retirement age.

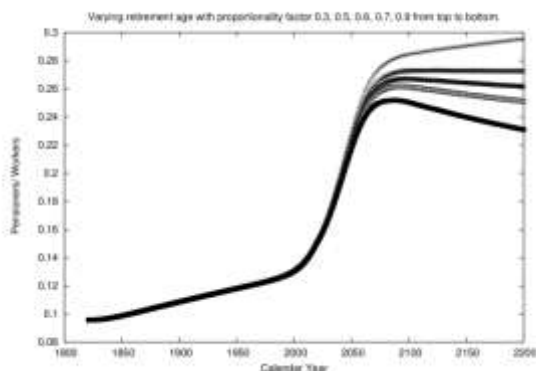


Fig.7: Actual retirement age versus calendar year, constant 20, for different initial retirement ages 50, 55, 60 and 65.

Figure 8 is a plot of the ratio pensioners to works for proportionality factor 0.3, 0.5, 0.6, 0.7, 0.9, which shows when the factor increases; the ratio of pensioners to workers decreases.

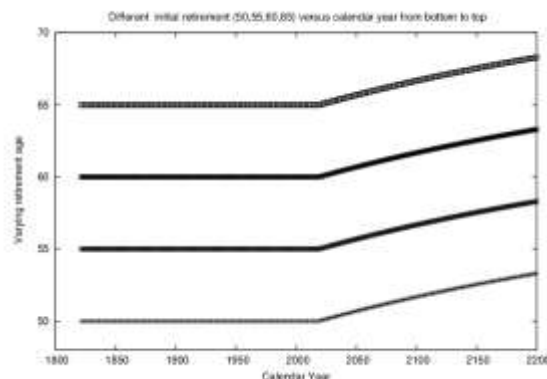


Fig. 8. Pensioner to work vs. calendar year for different proportionality factors (0.3,0.5,0.6,0.7,0.9) with initial retirement age 60 with constant 20.

We use a negative $c(-0.0051)$ for emigration, a positive $c(+0.0051)$ for immigration. As see from the fig.(9) emigration increases the ratio pensioner to worker, emigration reduces the age cohorts 6 to 40. Thus when the people emigrate the ratio of pensioners to workers increases.

Now we use the factor $war= 0.001$ on the main code, and see changes of life expectancy in figure 10 at constant retirement age 60, but no changes in the ratio of pensioners to workers. If the retirement age increases proportional to the increase in life expectancy (factor 0.6), war also changes the ratio but only very slightly ((not shown).

Conclusion:

We conclude that Palestinians will have problems similar to modern countries which now retire at an age between 60 to 70 years and for later years the strongest age cohorts will be near 72 years; Palestinian problems lie ahead only four decades later. Increasing the retirement age, and having more women working, may reduce the problems, and immigration instead of emigration reduces the ratio pensioner to worker

Acknowledgment:

Author thanks D. Stauffer for many valuable suggestions and fruitful discussions during the development of this work.

Appendix:

Statement increasing x after the year 1971; thus either b increases or x increases, as stated in the comment lines at the beginning of the program.

```
real*8s(0:130),pop(0:130),q(0:130),lifexp(0:5),A,b,x,x0
,babies
data x0/103/,A/
7.0/,birth0/2.17/,menop/40/,b0/0.07d0/,c/-.0051 /
1,d/0.04/,factor/0.6/,iatbirth/1/,CONST/20.0/,
war/0.000/
OPEN (UNIT=60,FILE='BirtDate37.DAT')
c Wilmoth x = x0 + d*t; Gavril.-Azbel-Gompertz f/b =
c A*exp(b(a-x))
c birth is the rate at which women of age 20 are
c "born"
c 500 iterations at b = b0, then b higher up to 1971:
c b rises from b0 to 0.093 within 150 years; then, x
c rises instead
c immigration of 5-40 years old
c x increasing after the year 1971; thus either b
c increases or x increases.
c JORGE SA MARTINS PARIS
b=b0
x=x0
ipens=60
fpens=0.0
do 3 iyear=1321,2200
if(iyear.eq.1948) WAR = 0.001
BIRTH = 6.9 + (2.1-6.9)*(1+TANH((IYEAR-
2012)/CONST))/2
c if(iyear.ge.1821) b=b0+(iyear-1821)*(0.093-b0)/150
if(iyear.ge.1821.and.iyear.le.1971) b=b0+(iyear-
1821)*(0.093-b0)/150
do 1 iage=0,130
s(iage)=dexp(-A*dexp(-b*x)*(dexp(b*iage)-
1.0d0))
c s = survival probability for Gompertz law
c pop = actual survivors, can be larger than one
c q = mortality function calculated from s
if(iyear.eq.1321) then
if(iage.eq.0) then
pop(iage)=1.0d0
```

```
else
pop(iage)=pop(iage-1)*(s(iage)/s(iage-1))
endif
endif
if(iage.gt.0) then
q(iage)=dlog(s(iage-1)/s(iage))
endif
c print *,iage,pop(iage),q(iage)
1 continue
if(iyear.gt.1971) x=x0+d*(iyear-1971)
babies=0.0d0
do 4 iage=21,menop
4 babies=babies+pop(iage)*(0.5d0/(menop-
20))*birth
pop(0)=babies
do 6 iage=130,1,-1
6 pop(iage)=pop(iage-1)*(s(iage)/s(iage-1))
c immigration
if(iyear.gt.2008) then
do 7 iage=6,40
7 pop(iage)=pop(iage)+total*c/35.0
DO 8 IAGE=0,130
8 POP(IAGE)=POP(IAGE)*(1.0-WAR)
endif
if(iyear.ge.2020) then
expectb=lifexp(mod(iyear,6))
expect=lifexp(mod(iyear+1,6))
if(expect.gt.expectb) then
fpens=fpens+factor*(expect-expectb)
if(fpens.ge.1.0) then
ipens=ipens+fpens
fpens=fpens-int(fpens)
endif
endif
endif
child=0.0
worker=0.0
pensio=0.0
total=0.0
expect=0.0
expectb=0.0
do 5 iage=1,130
s(iage)=s(iage)*(1.0-war)
expectb=expectb+s(iage)
if(iatbirth.eq.1) then
expect=expect+s(iage)
else
if(iage.eq.ipens) expect=expect+s(iage)*(1.0-
fpens)
if(iage.gt.ipens) expect=expect+s(iage)
endif
```

```

ss=pop(iage)
total=total+ss
if(iage.le.22) child=child+ss
if(iage.gt.22.and.iage.lt.ipens) worker=worker+ss
if(iage.gt.22.and.iage.eq.ipens)
  worker=worker+ss*fpens
if(iage.eq.ipens) pensio=pensio+ss*(1.0-fpens)
5  if(iage.gt.ipens) pensio=pensio+ss
if(iyear.ge.2010) lifexp(mod(iyear,6))=expect

if(s(130).gt.0.0001) stop
if(iyear.le.1820) goto 3
ss=0.5/(1000000.0*total)
do 2 iage=1,130
2  if(s(iage).lt.ss) goto 3
3  if(iyear.gt.1820) WRITE
1 (60,*)iyear,iage,ipens+fpens,total,b
1,pensio/total,birth,(child+pensio)/worker,x,expect,
1expecb,
1 PENSIO/WORKER
100 format(2i4,2f8.3,4f7.3,1f8.3,2f8.3)
stop
end

```

References:

M. Ya Azleb

1. L. Zekri and D. Stauffer, AIP Conf. Proc. 779, 69 (2005).
2. Fertility Determinations in the Palestinian Territory, In-Depth Analysis Study Series (02) (Palestinian Statistics, Ramallah, August 2003).

3. K. Bonkowska, S. Szymczak and S. Cebrat, Int. J. Mod. Phys. C 17, 1477 (2003); S. Cebrat and A. Laszkiewicz, J. Insur. Med. 37, 3 (2005)
4. D. Stauffer, S. M. de Oliveira, P. M. C. de Oliveira and J. S. Sa Martins, Biology, Sociology, Geology by Computational Physicists (Elsevier, Amsterdam, 2006).
5. M. Ya. Azbel, Proc. Roy. Soc. B 263, 1449 (1996); Proc. Natl. Acad. USA 91, 12453 (1994); Physica A 249, 472 (1998); Proc. Natl. Acad. USA 95, 9037 (1998).
6. E. Bomsdorf, Exp. Gerontology 39, 159 (2004); Suematsu, J. Theor. Biol. 201, 231 (1999).
7. A. I. Yashin, A. S. Begun, S. I. Boiko, S. V. Ukraintseva and J. Oeppen, Exp. Gerontology 37, 157 (2001).
8. J. R. Wilmoth, L. J. Deegan, H. Lundstrom and S. Horiuchi, Science 289, 2366 (2000).
- 9 J.S. Sa Martins and D. Stauffer, Ingenierias (Nuevo Leon, Mexico) 7, 35 (2004).
10. M. A. Sumour, A. H. El-Astal, M. M. Shabat; and M. A. Radwan, Int. J. Mod. Phys. C 18, 1717 (2007).