FTVG

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1 Health benefit

1.1 Life Expectancy

Life expectancy can be calculated by age and gender following the National Life Table, England based on the data for years from 2017 to 2019 [5]. Each step towards the life expectancy follow the Methodology used in the mentioned table and the instruction posted online [4]. However, some steps are skipped in the table while some of the equations are difficult to understand. I also referred two other methodologies [9, 8] in getting the life expectancy and the method used for our research is summered below.

1.1.1 m_x

From the National Life Table[5], we have m_x which is known as the central rate of mortality. This is the average number of deaths each year at age x last birthday in the relevant three-year period, divided by the average population at that age over the same period.

Example - m_x for age 70 years in 2015 to 2017 would be the average number of deaths at age 70 years across 2015, 2016 and 2017, divided by the average number of people aged 70 years across 2015, 2016 and 2017.

1.1.2 $\mathbf{q}_x$

q_x is the mortality rate between age x and $(x + 1)$. That is, the probability that a person aged x exactly will die before reaching age $(x + 1)$.

Example - q_x for age 70 years in 2015 to 2017 would be the probability that a person aged 70 years exactly in 2015, 2016 or 2017 will die before reaching age 71 years.

Therefore, for ages above 1 year, q_x can then be calculated using the following formula:
$q_x = 2 * m_x/(2 + m_x)$

1.1.3 l_x

$l_x$is the number of males or females surviving to exact age x of 100,000 live births who are assumed to be subject throughout their lives to the mortality rates experienced in the specified three-year period. As the life table is predefined to start with 100,000 simultaneous births, l0 equals 100,000.

Example: l_x for age 70 years in 2015 to 2017 would be the number of males or females out of 100,000 live births in 2015 to 2017 expected to survive to age 70 years calculated using the age specific mortality rates applicable for 2015 to 2017.

Therefore, the number of survivors to age x+1 is the number surviving to exact age x minus the deaths between exact age x and x+1:
$l_0 = 100,000$
$l_{x+1} = l_x - d_x$

1.1.4 d_x

d_x is the number of males or females dying between exact age x and (x +1) described similarly to l_x, that is:
$d_x = l_x – l_{x+1}$

1.1.5 T_x

T_x is the number of person years lived from age x to the oldest age. Therefore, this component should be calculated from the group of the oldest age (100 in this table).
$T_{year100)} = m_x * d_x$
$T_x = T_{x+1} + d_x/m_x$

Note that the dx/m_x is calculated for the average number of person years lived from age x to x+1.

1.1.6 $\mathbf{e}_x$

e_x is the average period life expectancy at exact age x, which is the average number of further years that those aged x exactly will live based on the mortality rates experienced in the specified three-year period.

Example - e_x for age 70 years in 2015 to 2017 would be the average number of further years that a person aged 70 years exactly in 2015, 2016 or 2017 could expect to live if they experienced the age-specific mortality rates of the given area for 2015 to 2017 for the rest of their life.

Summing the l_x column from age x to the oldest age gives the total number of years lived (T_x) from age x. The period expectation of life at exact age x is given by dividing the number of years lived by the number at that age, that is:

$\mathrm{e}_x = T_x/l_x$

1.2 Relative Risk

Relative risk (RR) is the ratio of the probability of an outcome in an exposed group to the probability of an outcome in an unexposed group. In our case, RR is the ratio of the rate of mortality for people who take exercise to the rate of mortality for people who do not take exercise.

Therefore, the rate of mortality (mx) of people who exercise equal the $m_x * RR$. RR is related to the level of exercise (LOE), which is the hour of cycling or walking per week in our case. According to the previous research (Rabl2012,Health2014,Andersen2000, for cycling, RR can be calculated by:

$\mathrm{RR}_{cycling} = 0.9231e^{\text{-0.07 LOE}}$

For walking, RR can be calculated by:

$\mathrm{RR}_{walking} = 0.9413e^{\text{-0.048 LOE}}$

1.3 Gain of Life Expectancy

The gain of life expectancy is the difference of life expectancy for people who exercise and the life expectancy for people who do not take any exercise. The life expectancy for people who exercise depends on the influence of exercise on the rate of mortality:

$\mathrm{mx}_{RR} = m_x * RR$

Therefore, following the above method until getting the year of life expectancy for people who exercise e_x^{RR}. The gap between the life expectancy for people who exercise and the life expectancy for people who do not take any exercise is the Gain of Life Expectancy (Gex):

$\mathrm{Gex} = \mathrm{e}_x - e_x^{RR}$

1.4 Metabolic Equivalents (METS)

This value is simple check from a table of Physical Activities Tracking [3]. Since we have the part of calories burn, I think this one may not that important. I think we can delete it to reduce the complexity.

1.5 Calories Burn

cycling Calories burned (CB) by biking can be calculated based on weight W as well as the time spent cycling $t_{cycling}$ in minutes.

Based on the table provide in this website [1], I find the trend line equation that can describe the relationships.

For people who has a body weight of about 150lb/68.1 kg, CB for cycling can be calculated by:

$\mathrm{CB} = \text{-}0.2038\ \mathrm{x}_{cycling}^4 + 9.4538t_{cycling}^3 - 156.4t_{cycling}^2 + 1136.9t_{cycling} - 2658.2$

for people who has a body weight of about 175lb/79.4 kg, CB for cycling can be calculated by:

$\mathrm{CB} = \text{-}0.2406\mathrm{t}_{cycling}^4 + 11.155t_{cycling}^3 - 184.52t_{cycling}^2 + 1340.4t_{cycling} - 3134.2$

for people who has a body weight of about 200lb/90.7 kg, CB for cycling can be calculated by:

CB = -0.285 $t^4_{cycling} + 13.196t^3_{cycling} - 218.03t^2_{cycling} + 1580.3t_{cycling} - 3698.2$

Walking Same method for finding the equation for walking based on the information posted on website [2].

for people who has a body weight of about 150lb/68.1 kg, CB for walking can be calculated by: CB = 4 $t^2_{walkcycling} + 28.6t^3_{walkcycling} + 181$

for people who has a body weight of about 175lb/79.4 kg, CB for walking can be calculated by: CB = -5.1667 -0.2406$t^3_{walking} + 43t^2_{walking} - 50.833t_{walking} +$ 2634

for people who has a body weight of about 200lb/90.7 kg, CB for walking can be calculated by: CB = -3.833 $t^2_{walking} + 29t^2_{walking} + 4.83t_{walking} + 238$

1.6 Equivalent to Kitkat

A bar (1.5 oz)(42g) of Kitkat chocolate wafer has 218 calories.

2 Environmental benefit

The value of air pollution in g/km is found in [7, 6].

References

[1] CaloriesBurnedHQ. Calories Burned Biking / Cycling Calculator, 2021.

[2] CaloriesBurnedHQ. Calories burned walking calculator, 2021.

[3] Office for National Statistics. The Compendium of Physical Activities Tracking Guide KEY. Technical report, 2011.

[4] Office for National Statistics. Guide to calculating national life tables - Office for National Statistics, 2019.

[5] Office for National Statistics. National life tables: England - Office for National Statistics, 2019.

[6] Office for National Statistics. Road transport and air emissions - Office for National Statistics, 2021.

[7] Office of Rail. Rail Emissions 2019-20. Technical report, 2019.

[8] Samuel H. Preston. Population Studies of Mortality. *Population Studies*, 50(3):525–536, nov 1996.

[9] James D. Tarver. Evaluation of Census Survival Rates in Estimating Intercensal State Net Migration. *Journal of the American Statistical Association*, 57(300):841, dec 1962.