PERIOD LIFE TABLES IN SUBURBAN AREAS: THE CASE OF THE ITALIAN MUNICIPALITY OF TARANTO

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1. Introduction

The city of Taranto has about 200 thousand inhabitants and extends for 250 km² strongly characterized by the presence of a vast industrial area that includes: an integral cycle steel mill (the largest in Europe); a large petrochemical refinery, active since 1967; a cement factory of national importance; two thermoelectric power plants; a relevant port area; two military arsenals; a NATO base; etc. Since the 1980s, together with the neighboring municipalities of Crispiano, Massafra, Montemesola and Statte, Taranto has been delimited and included among the areas at high risk of environmental crisis, and subsequently included among the top 14 sites of national interest (SIN) with high gravity environmental contamination, health risk and social alarm.

Several environmental, biomonitoring and also epidemiological studies conducted in the Taranto area have assessed industrial emissions and their impact on the territory, indicating strong air pollution originating mainly from the steel industry with the spread of particulate matter, heavy metals, polycyclic aromatic hydrocarbons and organ compounds halogenates, and showing an excess of mortality referred both to all causes and to neoplasms, in particular respiratory, pleural and bladder ones (Blangiardo and Rimoldi, 2013; Comba *et al.*, 2012; Graziano *et al.*, 2009; Mataloni *et al.*, 2012; Michelozzi, 2012; Stafoggia *et al.*, 2009; Zona *et al.*, 2019).

Mortality analysis is always connected to comparative assessments and needs of a territorial and/or temporal nature, to verify how the phenomenon varies geographically and/or over time. Istat deals extensively with some important surveys and calculations, starting from the monthly and annual demographic ones, from which data on the number of the population residing in the municipalities, on the movement of the population, and also on the natural balance (through the number of births and deaths reported monthly in the D7A and D7B forms and annually in the P2 and P3 forms that all municipalities draw up). Furthermore, the D4 and D4 bis models (the latter for deaths within the first year of life, which since 2013 have replaced and integrated the old D5 and D5 bis models) show the first four causes of death, certified by a ASL doctor, with subsequent WHO ICD-10 classification (Cervellera *et al*., 2014).

Using municipal registry sources, validated for more specific territorial disaggregation than the provincial Istat data, we calculated Taranto period life tables which represent an important tool for demographic analysis, structured by gender and neighborhood, in a decade (2010-2019) of strong socio-economic conflict, resulting in the well-known legal proceedings due to the situation of severe environmental pollution of the territory.

2. The period life tables

Period life tables represent an important tool for demographic analysis, for various reasons, to the point of being considered by many researchers to be the most complete logical-technical tool for the statistical analysis of mortality and its incidence by age and sex. They are based on a logical principle of description, in the form of tables, of the elimination by death of a generation[1] until the extinction of the last of the components, for which the main parameter of the study is the age-specific probability of death q_x: it expresses the risk that a person has of dying between the x-th birthday and the following birthday and it is an estimate of the age-specific death rate M_x.

The period life tables are obtained through different methods of detecting events: those of the first kind, *by generations* and those of the second kind, *by contemporaries*. The first type refers to the mortality of a contingent of individuals belonging to the same generation, i.e. born in the same year and followed over time until the death of all (generational analysis): given the extreme difficulty of following the contingent from the beginning and for the entire life course, one could fall back on a retrospective analysis which however would compromise the reliability of the results. To overcome these problems, reference is made to the second species period life tables, considering the set of contemporary individuals and therefore also of different ages (cross-sectional analysis). The methodology subsequently used is that of the tables for contemporaries, which is in any case the one generally used in demography for the study of the population: it would not be possible, here and for our purpose, to follow a generation of individuals up to death of the last.

Mainly, starting from the age-specific probability of death q_x, the period life tables determine some important biometric functions of the population aged x, such

[1] The initial generation of the born can be the real one, but also a theoretical one: in the latter case, a multiple of 10 (usually 10,000 or 100,000) is used as the initial value l_0, called the root.

as: the initial survivors l_x, the deaths d_x, the years lived L_x, up to the most important which is life expectancy $\dot{e}_x$ (Livi Bacci 1990, Preston et al. 2001). The period life tables are therefore a very useful tool in the comparative spatial and temporal analysis of the phenomenon in question.

3. The adopted methodology

We have elaborated abridged period life tables for suburban area such as neighborhoods, using an essentially different methodology from Istat one due to the fact that we do not re-elaborate the age-specific probabilities of death, which remain the real ones. This solution is valid as Taranto is demographically a large municipality, with about two thousand deaths every year (Tab. 1).

Table 1 – *Deaths in the districts of Taranto.*

Gender	District	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Female	Borgo-Città Vecchia	309	296	293	264	276	277	262	291	258	295
	Montegranaro-Salinella	227	217	243	216	252	236	239	237	285	267
	Paolo VI	53	45	43	48	56	66	66	52	71	73
	Talsano Lama S. Vito	125	145	124	128	171	161	143	179	133	164
	Tamburi	90	108	92	87	85	94	85	98	94	98
	Tre Carrare - Solito	218	222	215	230	210	227	226	251	251	245
Male	Borgo-Città Vecchia	236	258	246	230	238	270	221	235	229	241
	Montegranaro Salinella	195	225	211	211	225	204	221	214	233	216
	Paolo VI	54	51	72	55	67	66	74	68	73	98
	Talsano Lama S. Vito	132	169	159	164	158	167	166	172	200	165
	Tamburi	97	87	87	88	91	90	85	80	94	81
	Tre Carrare - Solito	185	208	189	200	216	206	209	188	181	228
Total		1,921	2,031	1,974	1,921	2,045	2,064	1,997	2,065	2,102	2,171

But since the number (D) of deaths is reduced in the suburban areas, we grouped data in two five-year periods: 2010-14 and 2015-19. And we also used age-classes with groups of s=5 years: $[x, x+s[$. In particular for the initial one, $q_{[0,\,5[}$, considering that in the first year of life, when mortality is generally higher, it results $q_0 \gg (q_1+q_2+q_3+q_4)$, we anyhow obtain a good estimate of life expectancy at birth: $e^0 \cong e^{[0,\,5[}$. Instead, the amplitude of the last class $[\text{int}(\omega_t/s)\cdot s,\ \omega_t]$ is variable, where ω_t is the highest age at death recorded in time-period t. This allows us to close the period life table at age ω_t and to determine the complete values of the last row of each table.

It differs from the methodology used by Istat which, based on a theoretical estimate built using a Kannisto model[2], closes all the tables at 125 years.

3.1. Determination of age-specific death rates

The age-specific death rate was determined with:

$$M_{[x,x+s[\,t} = \frac{D_{[x,x+s[\,t}}{\frac{1}{2}\left(P_{1.1.t}^{[x,x+s[} + P_{31.12.t}^{[x,x+s[}\right)} \tag{1}$$

for the two five-year periods t and for all age-groups with s=5 except for the class $[\text{int}(\omega_t/s)\cdot s,\ \omega_t]$ of amplitude ω_t–$\text{int}(\omega_t/s)\cdot s$.

3.2. Determination of the biometric functions

Once the age-specific death rates have been obtained, the age-specific probability of death can be determined, with a procedure similar to that of the age-specific death rates, using the Merrel and Reed method[3], getting

$$q_{[x,x+5[\,t} = 1 - e^{-M_{[x,x+5[\,t}\cdot\left(5+M_{[x,x+5[\,t}\right)} \tag{2}$$

and in particular for the last age group

$$q_{[\text{int}(\omega_t/s)s,\omega_t]\,t} = 1 - e^{-M_{[\text{int}(\omega_t/s)s,\omega_t]\,t}\cdot\left\{[\omega_t-\text{int}(\omega_t/s)s]+M_{[\text{int}(\omega_t/s)s,\omega_t]\,t}\right\}}. \tag{3}$$

This allows us to calculate also $l_{[\text{int}(\omega_t/s)s,\omega_t]\,t}$, $L_{[\text{int}(\omega_t/s)s,\omega_t]\,t}$ and the effective life expectancy for all classes, including the last: $\dot{e}_{[\text{int}(\omega_t/s)s,\omega_t]\,t}$ (Tab. 2 and Tab. 3).

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[2] Kannisto highlights how the rate of growth of the force of mortality decreases with advanced age and, therefore, no longer follows a linear form of Gompertz or an almost linear form of Gompertz-Makeham (Gompertz, 1825). Istat has been using it since 1996.

[3] The estimate of q_x proposed by Merrel and Reed is considered very efficient and is widely used in the international context, also used by Istat since 1992, so this use makes the results of the tables of the city of Taranto even more compatible and comparable with all the Istat period life tables.

Table 2 – *Period life table 2010-14.*

District	Age	q_x	l_x	d_x	L_x	e_x	q_x	l_x	d_x	L_x	e_x
		Female					Male				
Borgo - Città Vecchia	0-4	0.006	100000	568	498579	83.6	0.002	100000	221	499449	77.8
	5-9	0.001	99432	112	496878	79.0	0.001	99779	106	498631	73.0
	10-14	0.000	99319	0	496597	74.1	0.001	99673	103	498108	68.1
	15-19	0.000	99319	0	496597	69.1	0.000	99570	0	497851	63.1
	20-24	0.001	99319	94	496363	64.1	0.002	99570	177	497407	58.1
	25-29	0.001	99226	90	495903	59.2	0.002	99393	169	496541	53.2
	30-34	0.002	99136	164	495268	54.2	0.002	99224	238	495524	48.3
	35-39	0.003	98972	332	494029	49.3	0.007	98986	689	493206	43.4
	40-44	0.003	98640	315	492413	44.5	0.012	98297	1145	488620	38.7
	45-49	0.010	98325	996	489136	39.6	0.017	97151	1675	481568	34.1
	50-54	0.011	97329	1085	483932	35.0	0.022	95476	2081	472178	29.7
	55-59	0.012	96244	1138	478374	30.4	0.040	93395	3762	457570	25.3
	60-64	0.027	95106	2533	469196	25.7	0.078	89633	6971	430738	21.2
	65-69	0.041	92573	3788	453393	21.3	0.084	82662	6921	396009	17.8
	70-74	0.067	88784	5955	429036	17.1	0.119	75741	9045	356094	14.2
	75-79	0.117	82830	9689	389927	13.2	0.220	66696	14693	296748	10.8
	80-84	0.199	73141	14560	329304	9.6	0.324	52003	16839	217920	8.2
	85-89	0.426	58581	24962	230499	6.4	0.511	35165	17958	130927	5.9
	90-94	0.652	33619	21907	113325	4.2	0.620	17206	10668	59360	4.4
	95-ω	1.000	11711	11711	29278	2.5	1.000	6538	6538	16344	2.5
Montegranaro - Salinella	0-4	0.001	100000	131	499672	85.3	0.005	100000	489	498778	80.5
	5-9	0.000	99869	0	499344	80.4	0.000	99511	0	497556	75.9
	10-14	0.000	99869	0	499344	75.4	0.000	99511	0	497556	70.9
	15-19	0.000	99869	0	499344	70.4	0.002	99511	181	497103	65.9
	20-24	0.001	99869	81	499142	65.4	0.002	99330	240	496051	61.0
	25-29	0.001	99788	84	498730	60.4	0.003	99090	247	494833	56.2
	30-34	0.000	99704	0	498519	55.5	0.003	98843	249	493592	51.3
	35-39	0.001	99704	65	498358	50.5	0.004	98594	348	492099	46.4
	40-44	0.004	99639	351	497319	45.5	0.006	98246	587	489762	41.6
	45-49	0.008	99288	793	494460	40.7	0.008	97659	741	486443	36.8
	50-54	0.011	98496	1078	489783	36.0	0.018	96918	1725	480278	32.1
	55-59	0.007	97418	665	485425	31.3	0.028	95193	2618	469419	27.6
	60-64	0.021	96752	1987	478795	26.5	0.027	92575	2477	456683	23.3
	65-69	0.028	94766	2653	467196	22.0	0.065	90098	5864	435831	18.9
	70-74	0.055	92113	5106	447798	17.6	0.094	84234	7938	401327	15.0
	75-79	0.112	87006	9718	410738	13.5	0.171	76296	13058	348838	11.4
	80-84	0.200	77289	15466	347780	9.9	0.319	63239	20203	265685	8.2
	85-89	0.381	61823	23552	250236	6.7	0.475	43035	20449	164055	5.8
	90-94	0.640	38271	24500	130106	4.3	0.724	22587	16357	72041	3.9
	95-ω	1.000	13771	13771	34427	2.5	1.000	6230	6230	15575	2.5
Paolo VI	0-4	0.000	100000	0	500000	82.9	0.003	100000	345	499137	78.6
	5-9	0.000	100000	0	500000	77.9	0.002	99655	174	497839	73.8
	10-14	0.000	100000	0	500000	72.9	0.000	99481	0	497405	68.9
	15-19	0.000	100000	0	500000	67.9	0.000	99481	0	497405	63.9
	20-24	0.002	100000	174	499564	62.9	0.000	99481	0	497405	58.9
	25-29	0.002	99826	172	498698	58.0	0.004	99481	350	496530	53.9
	30-34	0.000	99653	0	498267	53.1	0.003	99131	309	494884	49.1
	35-39	0.000	99653	0	498267	48.1	0.001	98823	131	493784	44.3
	40-44	0.003	99653	249	497645	43.1	0.010	98691	988	490987	39.3
	45-49	0.008	99405	811	494996	38.2	0.015	97703	1452	484888	34.7
	50-54	0.011	98594	1061	490316	33.5	0.024	96252	2271	475580	30.2
	55-59	0.024	97533	2363	481755	28.8	0.041	93980	3807	460383	25.8
	60-64	0.026	95169	2521	469543	24.5	0.039	90173	3547	441999	21.8
	65-69	0.029	92648	2649	456618	20.1	0.086	86627	7444	414523	17.6
	70-74	0.080	89999	7195	432008	15.6	0.141	79183	11173	367982	14.0
	75-79	0.117	82804	9700	389770	11.8	0.199	68010	13526	306234	10.9
	80-84	0.337	73104	24631	303943	8.0	0.386	54484	21023	219860	8.0
	85-89	0.472	48473	22892	185135	5.8	0.411	33460	13762	132898	6.5
	90-94	0.761	25581	19456	79265	3.7	0.634	19699	12490	67270	4.3
	95-ω	1.000	6125	6125	15312	2.5	1.000	7209	7209	18023	2.5

Table 2 – *continued.*

District	Age	q_x	l_x	d_x	L_x	e_x	q_x	l_x	d_x	L_x	e_x
		Female					Male				
Talsano - Lama - S.Vito	0-4	0.002	100000	189	499527	84.7	0.002	100000	173	499566	80.8
	5-9	0.000	99811	0	499053	79.9	0.000	99827	0	499133	76.0
	10-14	0.000	99811	0	499053	74.9	0.000	99827	0	499133	71.0
	15-19	0.000	99811	0	499053	69.9	0.002	99827	154	498748	66.0
	20-24	0.001	99811	78	498857	64.9	0.002	99673	215	497827	61.1
	25-29	0.001	99732	78	498466	59.9	0.000	99458	0	497290	56.2
	30-34	0.001	99654	66	498106	55.0	0.002	99458	203	496784	51.2
	35-39	0.002	99588	216	497402	50.0	0.004	99255	445	495165	46.3
	40-44	0.005	99373	535	495526	45.1	0.005	98810	507	492785	41.5
	45-49	0.007	98838	739	492342	40.4	0.008	98303	785	489553	36.7
	50-54	0.006	98099	633	488913	35.6	0.014	97518	1345	484227	32.0
	55-59	0.012	97466	1197	484339	30.9	0.018	96173	1739	476516	27.4
	60-64	0.017	96269	1630	477272	26.2	0.039	94434	3697	462926	22.8
	65-69	0.037	94639	3474	464513	21.6	0.062	90737	5581	439732	18.7
	70-74	0.052	91166	4702	444073	17.3	0.106	85156	9035	403194	14.7
	75-79	0.126	86464	10887	405101	13.2	0.161	76121	12231	350031	11.2
	80-84	0.214	75577	16148	337515	9.7	0.355	63891	22686	262740	7.8
	85-89	0.398	59429	23652	238015	6.6	0.508	41205	20929	153703	5.8
	90-94	0.625	35777	22354	122999	4.4	0.679	20276	13766	66965	4.1
	95-ω	1.000	13423	13423	33557	2.5	1.000	6510	6510	16275	2.5
Tamburi	0-4	0.004	100000	402	498995	83.5	0.002	100000	208	499479	77.3
	5-9	0.000	99598	0	497991	78.8	0.000	99792	0	498958	72.5
	10-14	0.000	99598	0	497991	73.8	0.002	99792	189	498484	67.5
	15-19	0.000	99598	0	497991	68.8	0.000	99602	0	498011	62.6
	20-24	0.000	99598	0	497991	63.8	0.004	99602	369	497088	57.6
	25-29	0.003	99598	339	497143	58.8	0.004	99233	353	495283	52.8
	30-34	0.002	99259	184	495835	54.0	0.003	98880	339	493552	48.0
	35-39	0.002	99075	168	494955	49.1	0.002	98541	168	492285	43.2
	40-44	0.000	98907	0	494536	44.1	0.007	98373	659	490220	38.2
	45-49	0.006	98907	627	492969	39.1	0.020	97715	1950	483698	33.5
	50-54	0.003	98280	327	490585	34.4	0.018	95764	1713	474539	29.1
	55-59	0.017	97953	1627	485698	29.5	0.039	94051	3625	461193	24.6
	60-64	0.026	96326	2494	475395	24.9	0.070	90426	6327	436312	20.5
	65-69	0.065	93832	6139	453814	20.5	0.120	84099	10075	395306	16.8
	70-74	0.081	87694	7142	420614	16.8	0.137	74023	10135	344779	13.8
	75-79	0.108	80552	8705	380996	13.1	0.189	63888	12101	289189	10.5
	80-84	0.221	71847	15885	319521	9.4	0.395	51787	20433	207856	7.4
	85-89	0.430	55962	24054	219674	6.3	0.531	31355	16642	115170	5.6
	90-94	0.669	31908	21350	106162	4.2	0.661	14713	9731	49239	4.2
	95-ω	1.000	10557	10557	26393	2.5	1.000	4982	4982	12456	2.5
Tre Carrare - Solito	0-4	0.000	100000	0	500000	85.1	0.003	100000	276	499310	80.5
	5-9	0.000	100000	0	500000	80.1	0.000	99724	0	498620	75.7
	10-14	0.000	100000	0	500000	75.1	0.000	99724	0	498620	70.7
	15-19	0.000	100000	0	500000	70.1	0.002	99724	209	498097	65.7
	20-24	0.001	100000	92	499770	65.1	0.003	99515	271	496897	60.8
	25-29	0.000	99908	0	499539	60.2	0.003	99244	255	495583	56.0
	30-34	0.001	99908	88	499320	55.2	0.003	98989	345	494084	51.1
	35-39	0.002	99820	232	498521	50.2	0.007	98644	708	491450	46.3
	40-44	0.005	99588	496	496701	45.3	0.008	97936	792	487700	41.6
	45-49	0.006	99092	587	493993	40.5	0.013	97144	1247	482603	36.9
	50-54	0.013	98505	1241	489423	35.8	0.010	95897	930	477160	32.4
	55-59	0.013	97264	1261	483167	31.2	0.022	94967	2130	469510	27.7
	60-64	0.022	96003	2123	474709	26.6	0.037	92837	3411	455659	23.3
	65-69	0.032	93880	3022	461847	22.1	0.064	89426	5760	432731	19.0
	70-74	0.054	90858	4898	442048	17.8	0.101	83666	8430	397256	15.2
	75-79	0.098	85961	8420	408752	13.6	0.161	75236	12090	345955	11.6
	80-84	0.211	77540	16356	346811	9.9	0.274	63146	17304	272469	8.4
	85-89	0.379	61184	23190	247945	6.8	0.530	45842	24307	168441	5.6
	90-94	0.610	37994	23184	132009	4.4	0.698	21535	15027	70106	4.0
	95-ω	1.000	14810	14810	37024	2.5	1.000	6508	6508	16269	2.5

Table 3 – *Period life table 2015-19.*

District	Age	q_x	l_x	d_x	L_x	e_x	q_x	l_x	d_x	L_x	e_x
		Female					Male				
Borgo - Città Vecchia	0-4	0.003	100000	269	499329	84.0	0.011	100000	1089	497278	78.0
	5-9	0.000	99731	0	498657	79.2	0.001	98911	115	494270	73.9
	10-14	0.000	99731	0	498657	74.2	0.000	98797	0	493984	68.9
	15-19	0.000	99731	0	498657	69.2	0.004	98797	391	493005	63.9
	20-24	0.002	99731	205	498145	64.2	0.003	98405	273	491344	59.2
	25-29	0.004	99526	387	496665	59.4	0.003	98132	266	489998	54.3
	30-34	0.001	99139	97	495455	54.6	0.002	97867	178	488889	49.5
	35-39	0.003	99043	258	494569	49.6	0.004	97689	410	487419	44.6
	40-44	0.005	98785	543	492568	44.8	0.005	97279	493	485160	39.8
	45-49	0.011	98242	1107	488443	40.0	0.012	96785	1206	480912	34.9
	50-54	0.012	97135	1208	482655	35.4	0.026	95579	2514	471612	30.4
	55-59	0.012	95927	1125	476821	30.8	0.039	93066	3657	456186	26.1
	60-64	0.035	94801	3357	465616	26.2	0.047	89409	4160	436643	22.1
	65-69	0.040	91445	3623	448166	22.0	0.079	85249	6729	409421	18.0
	70-74	0.066	87822	5782	424654	17.8	0.116	78520	9082	369895	14.4
	75-79	0.111	82040	9114	387413	13.9	0.209	69438	14489	310968	10.9
	80-84	0.176	72926	12799	332630	10.3	0.326	54949	17929	229923	8.1
	85-89	0.348	60126	20913	248350	7.0	0.513	37020	18991	137623	5.8
	90-94	0.615	39214	24111	135791	4.4	0.628	18029	11326	61830	4.4
	95-ω	1.000	15103	15103	37757	2.5	1.000	6703	6703	16757	2.5
Montegranaro - Salinella	0-4	0.004	100000	431	498923	85.5	0.001	100000	145	499639	82.0
	5-9	0.000	99569	0	497846	80.8	0.000	99855	0	499277	77.1
	10-14	0.001	99569	105	497583	75.8	0.000	99855	0	499277	72.1
	15-19	0.001	99464	97	497078	70.9	0.001	99855	98	499033	67.1
	20-24	0.000	99367	0	496836	66.0	0.001	99758	92	498560	62.2
	25-29	0.000	99367	0	496836	61.0	0.001	99666	93	498098	57.2
	30-34	0.001	99367	96	496595	56.0	0.002	99573	193	497383	52.3
	35-39	0.003	99271	333	495523	51.0	0.003	99380	268	496231	47.4
	40-44	0.006	98938	584	493229	46.2	0.005	99112	509	494289	42.5
	45-49	0.004	98354	412	490737	41.5	0.011	98603	1093	490283	37.7
	50-54	0.009	97941	907	487439	36.6	0.010	97510	1012	485019	33.1
	55-59	0.008	97034	737	483330	32.0	0.024	96498	2325	476675	28.4
	60-64	0.024	96298	2315	475701	27.2	0.036	94172	3434	462275	24.0
	65-69	0.027	93983	2543	463556	22.8	0.058	90738	5283	440482	19.9
	70-74	0.053	91440	4853	445067	18.3	0.106	85455	9061	404623	15.9
	75-79	0.088	86587	7617	413891	14.2	0.137	76394	10456	355832	12.5
	80-84	0.165	78970	12999	362351	10.4	0.231	65939	15229	291620	9.1
	85-89	0.359	65971	23662	270701	6.9	0.470	50709	23831	193969	6.1
	90-94	0.622	42309	26322	145740	4.4	0.647	26878	17386	90926	4.3
	95-ω	1.000	15987	15987	39967	2.5	1.000	9492	9492	23731	2.5
Paolo VI	0-4	0.005	100000	461	498848	82.4	0.005	100000	453	498867	78.1
	5-9	0.000	99539	0	497697	77.8	0.000	99547	0	497734	73.5
	10-14	0.000	99539	0	497697	72.8	0.000	99547	0	497734	68.5
	15-19	0.002	99539	195	497209	67.8	0.005	99547	498	496490	63.5
	20-24	0.000	99344	0	496721	62.9	0.002	99049	170	494822	58.8
	25-29	0.000	99344	0	496721	57.9	0.002	98880	184	493938	53.9
	30-34	0.002	99344	182	496267	52.9	0.004	98695	383	492520	49.0
	35-39	0.002	99163	166	495399	48.0	0.007	98313	651	489936	44.1
	40-44	0.009	98997	872	492805	43.1	0.006	97662	552	486930	39.4
	45-49	0.008	98125	757	488733	38.4	0.009	97110	879	483352	34.6
	50-54	0.015	97368	1493	483107	33.7	0.031	96231	2953	473771	29.9
	55-59	0.022	95875	2078	474180	29.2	0.030	93278	2812	459357	25.8
	60-64	0.025	93797	2341	463133	24.8	0.050	90465	4493	441093	21.5
	65-69	0.037	91456	3412	448752	20.4	0.101	85972	8700	408109	17.5
	70-74	0.087	88045	7665	421060	16.1	0.110	77272	8512	365080	14.2
	75-79	0.146	80379	11761	372493	12.4	0.164	68760	11273	315618	10.6
	80-84	0.228	68618	15626	304025	9.0	0.344	57487	19747	238069	7.2
	85-89	0.421	52992	22310	209185	6.0	0.619	37740	23365	130288	4.7
	90-94	0.799	30682	24502	92153	3.5	0.838	14375	12050	41750	3.3
	95-ω	1.000	6179	6179	15449	2.5	1.000	2325	2325	5813	2.5

Table 3 – *continued.*

District	Age	q_x	l_x	d_x	L_x	e_x	q_x	l_x	d_x	L_x	e_x
		Female					Male				
Talsano - Lama - S.Vito	0-4	0.002	100000	233	499418	85.7	0.007	100000	662	498345	81.6
	5-9	0.001	99767	94	498601	80.9	0.000	99338	0	496690	77.1
	10-14	0.001	99673	90	498141	76.0	0.001	99338	84	496481	72.1
	15-19	0.000	99583	0	497916	71.1	0.000	99254	0	496271	67.2
	20-24	0.000	99583	0	497916	66.1	0.001	99254	79	496075	62.2
	25-29	0.000	99583	0	497916	61.1	0.001	99176	79	495679	57.2
	30-34	0.002	99583	162	497510	56.1	0.003	99096	342	494626	52.3
	35-39	0.001	99421	66	496938	51.2	0.001	98754	139	493423	47.4
	40-44	0.005	99355	501	495519	46.2	0.003	98615	285	492362	42.5
	45-49	0.006	98853	610	492741	41.4	0.008	98330	820	489598	37.6
	50-54	0.008	98243	753	489333	36.7	0.009	97510	923	485241	32.9
	55-59	0.006	97490	587	485983	31.9	0.019	96587	1865	478271	28.2
	60-64	0.012	96903	1149	481642	27.1	0.034	94722	3212	465578	23.7
	65-69	0.032	95754	3026	471204	22.4	0.056	91509	5151	444668	19.5
	70-74	0.046	92728	4230	453065	18.0	0.099	86358	8511	410513	15.5
	75-79	0.091	88498	8088	422270	13.8	0.151	77847	11719	359938	11.9
	80-84	0.197	80410	15857	362407	9.9	0.276	66128	18230	285066	8.6
	85-89	0.380	64553	24521	261462	6.7	0.477	47898	22871	182313	5.9
	90-94	0.634	40032	25365	136747	4.3	0.710	25027	17779	80687	3.9
	95-ω	1.000	14667	14667	36668	2.5	1.000	7248	7248	18119	2.5
Tamburi	0-4	0.003	100000	271	499323	84.0	0.000	100000	0	500000	78.0
	5-9	0.000	99729	0	498646	79.2	0.000	100000	0	500000	73.0
	10-14	0.000	99729	0	498646	74.2	0.002	100000	190	499524	68.0
	15-19	0.002	99729	211	498119	69.2	0.000	99810	0	499048	63.1
	20-24	0.000	99518	0	497591	64.3	0.006	99810	584	497589	58.1
	25-29	0.000	99518	0	497591	59.3	0.006	99226	594	494644	53.4
	30-34	0.000	99518	0	497591	54.3	0.006	98632	606	491643	48.8
	35-39	0.000	99518	0	497591	49.3	0.006	98026	555	488741	44.0
	40-44	0.004	99518	350	496716	44.3	0.012	97471	1215	484318	39.3
	45-49	0.011	99168	1067	493175	39.5	0.014	96256	1339	477933	34.7
	50-54	0.006	98101	625	488945	34.9	0.021	94917	1963	469679	30.2
	55-59	0.018	97477	1796	482894	30.1	0.035	92954	3217	456730	25.8
	60-64	0.022	95681	2136	473066	25.6	0.062	89737	5548	434818	21.6
	65-69	0.037	93545	3501	458973	21.1	0.076	84190	6382	404994	17.9
	70-74	0.058	90044	5253	437088	16.8	0.110	77808	8562	367635	14.1
	75-79	0.155	84791	13136	391115	12.7	0.173	69246	11966	316316	10.6
	80-84	0.223	71655	15975	318338	9.6	0.422	57280	24176	225962	7.3
	85-89	0.404	55680	22497	222158	6.6	0.525	33105	17366	122110	5.7
	90-94	0.611	33183	20283	115210	4.4	0.637	15739	10028	53627	4.3
	95-ω	1.000	12901	12901	32252	2.5	1.000	5711	5711	14279	2.5
Tre Carrare - Solito	0-4	0.007	100000	681	498297	84.9	0.003	100000	328	499181	81.9
	5-9	0.000	99319	0	496594	80.5	0.000	99672	0	498361	77.2
	10-14	0.001	99319	131	496265	75.5	0.000	99672	0	498361	72.2
	15-19	0.001	99187	119	495640	70.6	0.000	99672	0	498361	67.2
	20-24	0.001	99069	107	495077	65.7	0.001	99672	108	498092	62.2
	25-29	0.002	98962	194	494326	60.7	0.000	99564	0	497823	57.3
	30-34	0.000	98768	0	493842	55.9	0.004	99564	389	496849	52.3
	35-39	0.001	98768	95	493604	50.9	0.003	99175	295	495138	47.5
	40-44	0.005	98673	467	492199	45.9	0.005	98880	502	493146	42.6
	45-49	0.004	98206	419	489985	41.1	0.009	98378	894	489657	37.8
	50-54	0.010	97788	959	486541	36.3	0.012	97484	1137	484579	33.1
	55-59	0.014	96829	1394	480659	31.6	0.014	96347	1320	478436	28.5
	60-64	0.016	95435	1513	473392	27.0	0.046	95027	4370	464212	23.8
	65-69	0.034	93922	3166	461695	22.4	0.051	90658	4579	441840	19.9
	70-74	0.048	90756	4385	442817	18.1	0.095	86079	8206	409877	15.8
	75-79	0.108	86371	9307	408585	13.9	0.149	77872	11625	360300	12.2
	80-84	0.177	77063	13609	351293	10.3	0.249	66248	16519	289941	8.9
	85-89	0.355	63454	22503	261012	7.0	0.459	49729	22834	191560	6.0
	90-94	0.613	40951	25089	142033	4.4	0.700	26895	18840	87375	4.0
	95-ω	1.000	15862	15862	39656	2.5	1.000	8055	8055	20138	2.5

4 Analysis of the results

The scientific world and institutions have paid a great deal of attention to health conditions and to the analysis of the morbidity of diseases related to pollution and its related mortality in the Ionian area and, in particular, in the municipality of Taranto. The analysis with period life tables can assume great importance in ecological studies on the health of citizens, precisely when done in smaller areas than the Istat provincial aggregate data: our analysis allows to determine the period life tables for suburban area such as the 6 districts of the City of Taranto.

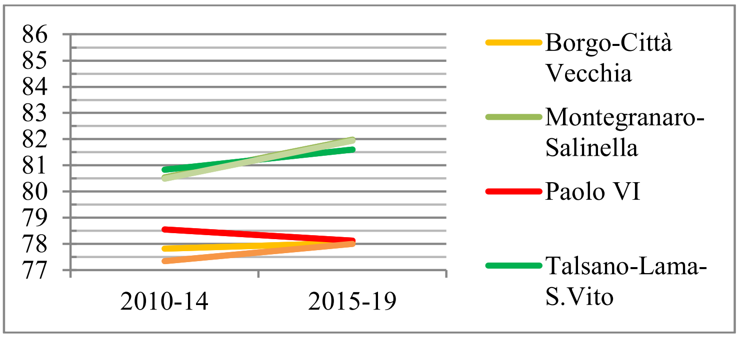
The districts of Taranto show a strong inequality of mortality detected in the biometric functions. The northern districts (Paolo VI, Tamburi and Borgo-Città Vecchia) have a much shorter life expectancy at birth in the entire 2010-19 period than the southern districts (Tre Carrare-Solito, Montegranaro-Salinella and Talsano-Lama-S.Vito). As for women (Fig. 1), Paul VI represents the most problematic district, with the lowest expectation already in the five-year period 2010-14 (82.9 years) which even decreases in 2015-19 (82.4 years) demonstrating the presence of adverse public health situations. For men (Fig. 2), however, the Tamburi district is the most problematic in the two periods (77.3 and 78.0 years). The range of variation in life expectancy at birth for women goes from 2.35 years in 2010-14 to 3.32 years in 2015-19, while for men it goes from 3.49 to 3.98 years. All indicates how in the city of Taranto there is an increase in internal territorial health inequality for citizens residing in the north (therefore closer to the notorious industrial area) compared to those living in the south districts.

This evidence available for the suburban areas of Taranto shows a health and environmental picture with multiple critical aspects, claiming for primary prevention interventions and continuous monitoring of the health status of the population. This would require a feasible tool to rapidly perform a preliminary assessment of population health status every year, preferably based on official data provided by the same municipality and able to allow epidemiological comparison between different years, age groups, gender and neighborhoods.

Furthermore, it comes out how the analysis at suburban level shows that for medium-large cities it is necessary to analyze the mortality at the district level, given that the higher mortality in the entire municipality is essentially attributable to a significant excess of mortality among residents in some neighborhoods. This could be particularly true in cities that suffer from severe environmental pressures that are not widespread but located in specific areas of the city such as the large steel plant in the north-western part of Taranto.

Figure 1 – *Female life expectancy at birth in the districts of Taranto.*

Figure 2 – *Male life expectancy at birth in the districts of Taranto.*



5 Final remarks

In cities suffering from heavy environmental pressure or pollution, it is extremely important to rapidly access municipal demographics that can be used as indicators of population health status. Among those, mortality rates represent the most reliable data as they are officially retained and available to municipality with high level of details, thus allowing epidemiological comparison between different neighborhoods of the city across several years.

Our study was aimed at validating and propose as universally applicable approach the use of municipal demographics as first-line tool to rapidly assess population health and drive health policies or urban planning in cities characterized by heavy environmental pressure. The case study of Taranto has been chosen due to the presence of the biggest European steel plant since 1960s resulting in heavy burden on environment and population health.

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SUMMARY

Period life tables in suburban areas: the case of the Italian municipality of Taranto

Using municipal registry sources, validated for more specific territorial disaggregation than the provincial Istat data, we obtained Taranto period life tables which represent an important tool for demographic analysis, structured by gender and neighborhood, in a decade (2010-2019) of strong socio-economic conflict, resulting in the well-known legal proceedings due to the situation of severe environmental pollution of the territory. The use of municipality data can be considered a methodological approach that allows a timely, reliable and costless first-line assessment system of the population status and drive urban planning policies in cities suffering from heavy environmental pressures: from the period life tables in suburban areas, a situation of strong inequality emerges, as Borgo-Città Vecchia, Paolo VI and Tamburi districts are united by the levels of life expectancy very detached from the others, as if they were different cities. The epidemiological and environmental evidence available for the Taranto area shows various critical aspects, claiming for primary prevention interventions and continuous monitoring of the health status of the population which can provide important indications for urban planning policies.

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