



BMJ Open Differences in mortality between temporary and permanent workers: results from the Rome Longitudinal Study

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ABSTRACT

Objective Precarious employment is characterised by instability, lack of protection and economic vulnerability. The objective of this study was to assess the association between temporary contracts and mortality.

Design Cohort study.

Setting Rome, Italy.

Participants All employees, aged 25–65 years, from the Rome Longitudinal Study, followed from 21 October 2001 to the first date among death, migration from Rome, or 31 December 2015.

Primary and secondary outcome measures We investigated all-cause, cardiovascular and accidental mortality. We considered gender, age, place of birth, education, temporary versus permanent contract and sector of employment. We used Cox models to investigate the association between type of contract and total, cardiovascular and accidental mortality in men and women, overall and by employment sector.

Results We analysed 597 834 subjects. The proportion of temporary contracts varied by gender (9.6% in men and 13.3% in women) and by employment sector, ranging from 4.5% (public administration) to 27% (recreational, cultural, sports activities) in men. During the study period, 21 136 subjects died. Men with temporary contracts, compared with those with permanent positions, had greater overall mortality risk (HR=1.16, 95% CI 1.09 to 1.24), cardiovascular mortality (HR=1.29, 95% CI 1.14 to 1.45) and accidental mortality (HR=1.27, 95% CI 1.04 to 1.57). In men, the association varied widely among different economic sectors, with greater risks in the industry, building constructions and social services sectors. In women, there was no evidence of association between temporary contracts and mortality. A statistically significant association between temporary contracts and mortality in women was found in the sector of sales and transports only.

Conclusions Temporary work should be considered a determinant of health, particularly for specific economic sectors.

INTRODUCTION

During the last decades, increased flexibility in the labour market led to the spread of various forms of non-standard and precarious

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The study was based on 597 834 employees aged between 25 and 65 years residents in a metropolitan area, followed for 14 years.
- ⇒ Census information linked to health data allowed a detailed analysis of health outcomes related to temporary work.
- ⇒ The information on the sector of employment allowed to investigate health outcomes related to temporary work in specific sectors.
- ⇒ The lack of information about job histories was a strong limit of our study.
- ⇒ There was a lack of information on employees' health and behavioural risk factors.

employment in Europe.¹ Due to the growth of evidence on the potential implications on health status, precariousness has been suggested as an emerging social determinant of health.² Some studies showed a social gradient in precarious contracts regarding the educational level and job type.^{3 4} In addition, a higher proportion of precarious contracts was reported among women,⁵ young adults¹ and migrants.⁶

Despite the growing body of research, some concerns remain about the definition of precarious employment. According to the seminal work of Rodgers and Rodgers,⁷ precariousness is a complex construct that encompasses different dimensions involving employment instability and insecurity, lack of protection and economic vulnerability. Although some multidimensional methods have been developed to assess precariousness,^{8 9} in public health research, it is frequent to focus on a specific domain using a one-dimensional approach. Within these domains, temporary employment, an objective measure of precariousness, is one of the most investigated.¹⁰

Few studies analysed the effect of type of contract on mortality, showing an association between temporary contracts and mortality in specific subgroups of workers.^{11–14} However, all mortality studies were conducted in Nordic European countries, and none investigated the impact of temporary contracts among different economic sectors. As the rate of temporary contracts may vary widely among economic sectors, the latter were evaluated as confounding factors.¹³ Due to the worse working conditions of temporary employees, it is reasonable to hypothesise a joint effect between sector-related and contract-related health risks. Therefore, analysing the association between temporary contracts and mortality by employment sector could be more appropriate than adjusting for this variable.

In Italy, reforms in the labour market legislation followed the European trend. Changes in the legislation were carried out during the last decades, starting with the ‘Treu law’ in 1997. This reform introduced temporary contracts and modified regulation of fixed-term contracts, producing more flexibility and consequently more instability in the labour market. Thus, this study aimed to assess the association between temporary contracts and all-cause and cause-specific mortality among a cohort of employees between 2001 and 2015 in Rome. We hypothesised that the association between temporary contracts and mortality could be stronger in sectors characterised by manual work, where uncertainty due to the temporary contracts might be a proxy of precariousness more than in non-manual sectors. Also, temporary manual workers might use personal protective equipment less than workers with permanent positions.

METHODS

Study design

We used the Rome Longitudinal Study, the administrative cohort of residents in Rome who filled in the 2001 population census. The study, which has been already described, included all subjects who were not living in institutions on the census reference day, 21 October 2001.^{15–17} We followed the subjects using record-linkage procedures with administrative databases, under strict control to protect individual privacy. We used the Municipal Registry for vital status and migration and Mortality Registry for the cause of death (coded according to the International Classification of Disease, 9th Revision, ICD-9). The follow-up started on the census reference day and ended on the day of death, of migration from Rome, or 31 December 2015, whichever came first. The Rome Longitudinal Study was part of the National Statistical Program 2019 and was approved by the Italian Data Protection Authority.

Setting and participants

Rome is the capital of Italy, and it is the largest Italian city with about 2.5 million inhabitants on a surface of 1290 km² at 2001 census.

In this study, we selected all employees aged 25–65 years at baseline (78% of the employed population).

Patient and public involvement

Patient involvement in the study was not possible, as individual contact information was unavailable because of privacy restrictions. However, due to the topic’s relevance, the purpose is to disseminate study results to both population and policy-makers, to implement health promotion and prevention strategies in temporary workers of specific economic sectors.

Outcomes

We analysed all-cause mortality, cardiovascular mortality (ICD-9 codes 390–459), and accidental mortality (ICD-9 codes 800–999).

Temporary employment, sector of employment and other variables

The census included a large amount of information regarding the occupation for the population aged 15 years or more: occupational status, a binary variable identifying employees and self-employed, the sector of employment, and for employees only, the distinction between temporary and permanent contracts.

The sector of employment was categorised in 28 categories grouped in 7 groups, named macrosectors. Sectors were classified as in the 2001 Italian census by the Italian National Institute of Statistics.¹⁸

Among other census variables, we selected gender, date of birth, level of education (coded as low for junior high school or less, medium for high school and high for university or more) and place of birth (Rome, Italy and abroad).

Statistical analyses

We computed sex-specific crude mortality rates by age class, type of contract, level of education and place of birth. We used Cox proportional hazard models to investigate the association between type of contact (temporary vs permanent employee) and total and cause-specific mortality in men and women, overall and by employment sector. We used time of follow-up as time axis and stratified the baseline hazard function by age. We tested for interaction between temporary contract and employment sector using the log-likelihood ratio test.

Additional analyses

As additional analyses, we performed the Cox regression stratifying the baseline hazard function by age, level of education and place of birth.

As a sensitivity analysis, we performed Cox proportional hazard models to investigate the association between type of contact and mortality until 31 December 2006, allowing only 5 years of follow-up, under the hypothesis that the information on temporary employment at 2001 census could be more reliable in the first years after the census.

Assuming that temporary workers are more likely to migrate in search of a better position, we used an inverse

probability weighting approach to handle missing information on deaths due to lost to follow-up due to migration.¹⁹ First, we estimated sex-stratified probability (P) of non-emigration as a function of age, education, type of contract and place of birth using logistic regression models. Then, we estimated the probability (P') of non-emigration as a function of age only to calculate stabilised weights (W) as P'/P. Finally, we performed weighted Cox regression models on non-migrants using the weights W.

Since the type of contract might partly reflect the well-known health differences in occupational classes, we further analysed the association between temporary employment and mortality for each occupational class, categorised as manual workers, sale or service workers, low-skill non-manual workers and high-skill non-manual workers.

RESULTS

The cohort included in the study was composed by 597 834 employees aged between 25 and 65 years (53.6% men and 46.4% women), followed for a mean of 12.9 years resulting in a total of 7 712 058 person years.

Table 1 shows the main sociodemographic characteristics, overall and cause-specific mortality of the study population. The percentage of temporary workers was higher in the youngest age class (20.2% in men and 24.6% in women), in the lower educational level (10.2% in men and 13.3% in women) and in people born abroad (14.0% in men and 18.4% in women). Women had a higher proportion of temporary contracts than men (13.3% vs 9.6%) and were more educated than men (26.5% vs

Table 1 Characteristics of the study population

	N	%	% Temporary workers	Number of deaths	% CV deaths	% AC deaths	CMR
Men							
Total	320 654	100.0	9.6	14 290	26.5	6.2	35.1
Age class							
25–34	83 837	26.1	20.2	725	20.6	34.3	7.0
35–44	102 024	31.8	6.9	2035	25.7	12.1	15.4
45–54	89 910	28.0	4.7	5195	27.3	4.3	44.6
55–65	44 883	14.0	6.0	6335	26.9	2.6	113.2
Education							
High	70 356	21.9	9.9	2585	26.7	5.5	28.5
Medium	144 897	45.2	9.1	5017	26.5	7.1	27.2
Low	105 401	32.9	10.2	6688	26.5	5.8	50.5
Place of birth							
Rome	200 499	62.5	10.9	7671	26.1	7.1	29.9
Italy	104 735	32.7	6.6	6180	27.0	4.8	46.8
Abroad	15 420	4.8	14.0	439	28.0	9.1	23.6
Women							
Total	277 180	100.0	13.3	6846	14.6	3.8	18.9
Age class							
25–34	80 257	29.0	24.6	421	11.4	15.4	4.1
35–44	93 520	33.7	11.3	1344	11.5	5.1	10.8
45–54	75 688	27.3	6.3	2816	13.2	3.1	28.0
55–65	27 715	10.0	6.9	2265	18.7	1.9	62.9
Education							
High	73 511	26.5	15.0	1551	12.5	3.6	16.0
Medium	140 773	50.8	12.4	2918	12.7	4.4	15.8
Low	62 896	22.7	13.3	2377	18.1	3.3	29.2
Place of birth							
Rome	176 768	63.8	14.4	3909	13.6	4.2	16.8
Italy	83 400	30.1	10.2	2603	15.7	3.1	23.9
Abroad	17 012	6.1	18.4	334	17.7	5.4	15.8

AC, accidental; CMR, crude mortality rate per 10 000 person-years; CV, cardiovascular.

21.9% high educational level). More than one-third of the employees were born outside Rome, and 4.8% of men and 6.1% of women were born abroad. In the period of interest, there were 21 136 deaths (35.1 and 18.8 per 10 000 person years in men and women, respectively). In men and women, cardiovascular deaths accounted for 26.5% and 14.6% of all deaths, respectively, whereas accidental deaths for 6.2% in men and 3.8% in women. Accidental mortality was almost twice as high for temporary compared with permanent workers in both men (10.9% vs 5.8%) and women (6.7% vs 3.6%) (not shown in table).

Main characteristics by occupational sectors for men and women are shown in online supplemental material. In men (online supplemental table S1), the macrosector with the highest percentage of temporary employees was fishing and agriculture (14.7%). The sector with the highest proportion of temporary workers was recreational, cultural and sports activities, within the macrocategory of social services, with 27.1%. Online supplemental table S1 highlights the differences among sectors in terms of socioeconomic position and origins. The education sector had the highest proportion of highly educated employees (62.9%), followed by the health and social assistance sector (45.7%), whereas the sectors with the lowest proportion were hotels, bars and restaurants (4.8%) and domestic services (4.9%). The proportion of foreigners varied among sectors, with the highest percentage in domestic services (32.1%) followed by international organisations (20.6%). Women showed higher percentages of temporary contracts than men in all macrosectors (online supplemental table S2). In women, the macrosectors with the highest rate of temporary employees were fishing and agriculture (20.4%), international organisations (17.6%) and sales and transport (14.6%). Conversely, the lowest proportion was in social services (12.5%). However, in this macrosector, there was great variability, with the percentage of temporary workers ranging between 31.2% of recreational, cultural and sporting activities and 5.9% of local, national and public administration.

Table 2 shows the association between temporary employment and mortality overall and by employment macrosector in men and women. Age-adjusted Cox regression models showed greater overall mortality risk for temporary workers in men (HR 1.16, 95% CI 1.09 to 1.24) but not in women (HR 1.03, 95% CI 0.95 to 1.12). The likelihood ratio tests, comparing the models with and without the interaction term between type of contract and sector of employment, were statistically significant in both men ($p=0.04$) and women ($p=0.04$). Among macrosectors, industry (HR 1.26, 95% CI 1.07 to 1.49), building constructions (HR 1.29, 95% CI 1.08 to 1.54) and social services (HR 1.11, 95% CI 1.00 to 1.25) showed greater overall mortality risks in men, whereas women had higher mortality in sales and transports sector (HR 1.23, 95% CI 1.01 to 1.49). Overall, in men, temporary workers had higher cardiovascular mortality than those with permanent positions (HR 1.29, 95% CI 1.14 to 1.45),

particularly in the macrosectors of sales and transports (HR 1.33, 95% CI 1.05 to 1.68) and social services (HR 1.26, 95% CI 1.03 to 1.55). In women, although the HRs were greater than one in several macrosectors, there was no evidence of an association between type of contract and cardiovascular mortality. Temporary workers had a higher risk of accidental mortality than workers in permanent positions in men (HR 1.27, 95% CI 1.04 to 1.57), but not in women (HR 1.34, 95% CI 0.94 to 1.91).

Table 3 shows the association between temporary employment and overall, cardiovascular, and accidental mortality in men by specific employment sector. There was an association with overall mortality, with higher risks in subjects with temporary compared with permanent contracts, in the steel industry sector (HR 1.34, 95% CI 1.04 to 1.71) and in the public administration (HR 1.20, 95% CI 1.01 to 1.43). Higher cardiovascular mortality risks were found in the sector of production and distribution of electricity, water and gas (HR 3.85, 95% CI 1.50 to 9.83), in the retail and trade sector (HR 1.72, 95% CI 1.07 to 2.77), in the sector which includes professional consulting, real estate and rental (HR 1.98, 95% CI 1.13 to 3.49) and public administration (HR 1.56, 95% CI 1.15 to 2.11). There was a higher risk for accidental mortality in two sectors: steel industry (HR 2.01, 95% CI 1.04 to 3.87) and wholesale trade and intermediaries of trade (HR 4.48, 95% CI 1.52 to 13.25) with wide CIs due to the small number of deaths. Since there was no evidence of an association between type of contract and overall mortality in women, we did not investigate the possible association in specific sectors.

Online supplemental table S3 shows the results from Cox regression models adjusted for age and level of education, and then for age, level of education and place of birth. Adjusting for the level of education and place of birth slightly reduced the HR for all statistically significant results except for public service in men and sales and transport in women, which presented an increase.

The sensitivity analysis conducted with a follow-up from 2001 to 2006 confirmed the results on overall and cardiovascular mortality in men. Results on accidental mortality were based on 345 cases and were not statistically significant. Online supplemental table S4 shows the results of the association between temporary employment and overall mortality by macrosectors ending the follow-up in December 2006. The results were similar, although the scarcity of events in the first 5 years of follow-up did not allow having statistically significant associations. There were no differences in HRs for overall and cause-specific mortality using the inverse probability approach: for overall mortality the HRs of temporary versus permanent contracts were 1.17 (95% CI 1.10 to 1.25) and 1.04 (95% CI 0.95 to 1.14) for men and women, respectively.

Online supplemental table S5 shows the results of the association between temporary employment and overall mortality by type of work. Manual and sale or service workers with temporary contracts showed significantly higher overall mortality than those with permanent

Table 2 Association between temporary employment and mortality overall and by macrosector of employment

	N		Overall mortality		N		CV mortality		N		AC mortality	
	Deaths	HR	95% CI	HR	Deaths	HR	95% CI	HR	Deaths	HR	95% CI	
Men												
Overall	320 654	14 290	1.09 to 1.24	1.16	3793	1.29	1.14 to 1.45	1.27	884	1.27	1.04 to 1.57	
Macrosector of employment*												
Fishing and agriculture	3927	271	0.56 to 1.22	0.83	67	1.41	0.73 to 2.71	0.92	19	0.92	0.26 to 3.29	
Industry	44 568	1897	1.07 to 1.49	1.26	502	1.17	0.84 to 1.62	1.58	130	1.58	0.96 to 2.61	
Building constructions	21 058	1047	1.08 to 1.54	1.29	290	1.31	0.94 to 1.83	1.19	86	1.19	0.67 to 2.1	
Sales and transports	79 626	3265	0.98 to 1.27	1.12	859	1.33	1.05 to 1.68	1.1	225	1.1	0.74 to 1.64	
Credit, insurances and other services	51 771	1806	0.89 to 1.37	1.11	476	1.2	0.8 to 1.81	0.95	88	0.95	0.42 to 2.17	
Social services	117 812	5910	1 to 1.25	1.11	1573	1.26	1.03 to 1.55	1.36	329	1.36	0.94 to 1.97	
Women												
Overall	277 180	6846	0.95 to 1.12	1.03	997	1.02	0.81 to 1.28	1.34	262	1.34	0.94 to 1.91	
Macrosector of employment*												
Fishing and agriculture	3032	114	0.41 to 1.23	0.71	27	0.53	0.16 to 1.77	-	1	-	-	
Industry	19 721	423	0.73 to 1.39	1.01	70	1.61	0.82 to 3.19	2.21	24	2.21	0.81 to 6.06	
Building constructions	3612	74	0.38 to 2.1	0.89	12	3.56	0.86 to 14.7	-	3	-	-	
Sales and transports	51 334	980	1.01 to 1.49	1.23	132	1.31	0.79 to 2.16	1.57	46	1.57	0.72 to 3.45	
Credit, insurances and other services	42 745	727	0.68 to 1.19	0.9	89	0.77	0.33 to 1.8	0.95	33	0.95	0.32 to 2.83	
Social services	154 755	4493	0.91 to 1.13	1.01	665	0.85	0.62 to 1.17	1.22	155	1.22	0.75 to 1.98	

HRs adjusted for age. Men and women, Rome 2001–2015.

*International organisations sector, contributing with 94 and 35 deaths for men and women respectively, was not shown. AC, accidental; CV, cardiovascular.

Table 3 Association between temporary employment and mortality by specific sector

	N		Overall mortality		N		CV mortality		N		AC mortality	
	N	Deaths	HR	95% CI	Deaths	95% CI	HR	95% CI	Deaths	95% CI	HR	95% CI
Overall	320 654	14 290	1.16	1.09 to 1.24	3793	1.29	1.14 to 1.45	1.27	1.04 to 1.57	884	1.27	1.04 to 1.57
Sector of employment*												
Fishing and agriculture	3927	271	0.83	0.56 to 1.22	67	1.41	0.73 to 2.71	0.92	0.26 to 3.29	19	0.92	0.26 to 3.29
Agriculture, hunting, forestry	3620	250	0.84	0.57 to 1.26	65	1.38	0.72 to 2.67	0.69	0.15 to 3.12	17	0.69	0.15 to 3.12
Fishing, fish farming	307	21	0.68	0.08 to 5.97	2	-	-	-	-	2	-	-
Industry	44 568	1897	1.26	1.07 to 1.49	502	1.17	0.84 to 1.62	1.58	0.96 to 2.61	130	1.58	0.96 to 2.61
Coal mining, oil extraction	1829	86	1.78	0.74 to 4.3	21	0.88	0.1 to 7.88	-	-	4	-	-
Food industry	3979	171	1.28	0.76 to 2.16	46	1.86	0.78 to 4.47	0.68	0.08 to 5.44	13	0.68	0.08 to 5.44
Textile, leather industry	2035	107	0.72	0.35 to 1.5	36	1.3	0.45 to 3.8	-	-	5	-	-
Wood, wood products industry, publishing	5174	225	1.06	0.63 to 1.77	63	0.46	0.11 to 1.91	0.62	0.07 to 5.5	10	0.62	0.07 to 5.5
Refinery, pharmaceutical, chemical industry	5959	211	1.09	0.62 to 1.92	53	1.02	0.34 to 3.05	1.37	0.27 to 6.87	14	1.37	0.27 to 6.87
Non-metal mineral industry	1348	71	1.17	0.59 to 2.34	27	1.01	0.3 to 3.47	-	-	4	-	-
Steel industry	17 755	728	1.34	1.04 to 1.71	187	0.85	0.48 to 1.52	2.01	1.04 to 3.87	64	2.01	1.04 to 3.87
Furniture industry	1651	89	1.49	0.79 to 2.83	16	1.69	0.36 to 7.95	-	-	5	-	-
Production, distribution of electricity, water and gas	4838	209	0.89	0.39 to 2.02	53	3.85	1.5 to 9.83	-	-	11	-	-
Building constructions	21 058	1047	1.29	1.08 to 1.54	290	1.31	0.94 to 1.83	1.19	0.67 to 2.1	86	1.19	0.67 to 2.1
Sales and transports	79 626	3265	1.12	0.98 to 1.27	859	1.33	1.05 to 1.68	1.1	0.74 to 1.64	225	1.1	0.74 to 1.64
Sale, maintenance, repair of motor vehicles, sale of fuel	8449	345	0.91	0.61 to 1.37	77	1.76	0.89 to 3.48	1.31	0.37 to 4.61	20	1.31	0.37 to 4.61
Wholesale trade, intermediaries of trade	7795	261	1.1	0.71 to 1.7	66	0.85	0.34 to 2.15	4.48	1.52 to 13.25	16	4.48	1.52 to 13.25
Retail trade	13 546	547	1.1	0.84 to 1.44	130	1.72	1.07 to 2.77	0.62	0.22 to 1.79	40	0.62	0.22 to 1.79
Hotels, camping, bars, restaurants	13 147	561	1.12	0.86 to 1.46	154	1.09	0.65 to 1.84	1.66	0.85 to 3.25	51	1.66	0.85 to 3.25
Transport	36 689	1551	1.14	0.92 to 1.43	432	1.31	0.87 to 1.97	0.59	0.26 to 1.33	98	0.59	0.26 to 1.33
Credit, insurances and other services	51 771	1806	1.11	0.89 to 1.37	476	1.2	0.8 to 1.81	0.95	0.42 to 2.17	88	0.95	0.42 to 2.17
Credit, insurance, monetary, financial intermediation	23 179	1059	1.17	0.83 to 1.65	265	1.05	0.51 to 2.16	1.19	0.32 to 4.37	49	1.19	0.32 to 4.37
IT, research, development	18 870	383	0.57	0.33 to 1	114	0.34	0.08 to 1.37	0.47	0.06 to 3.74	22	0.47	0.06 to 3.74
Professional consulting, real estate, rental	9722	364	1.33	0.96 to 1.84	97	1.98	1.13 to 3.49	1.05	0.28 to 3.94	17	1.05	0.28 to 3.94
Social services	117 812	5910	1.11	1.00 to 1.25	1573	1.26	1.03 to 1.55	1.36	0.94 to 1.97	329	1.36	0.94 to 1.97
Local, national, public administration	66 677	3245	1.2	1.01 to 1.43	879	1.56	1.15 to 2.11	1.68	0.95 to 3	174	1.68	0.95 to 3
Public, private education	15 276	897	1.27	0.97 to 1.67	230	1.54	0.93 to 2.55	0.87	0.3 to 2.52	43	0.87	0.3 to 2.52
Health, social assistance	19 331	1003	0.88	0.66 to 1.17	277	0.91	0.53 to 1.57	0.67	0.21 to 2.21	62	0.67	0.21 to 2.21
Political, trade union organisations	2404	111	1.01	0.52 to 1.95	33	0.77	0.18 to 3.36	-	-	3	-	-
Recreational, cultural, sports activities	5143	217	1.17	0.84 to 1.64	49	1.48	0.75 to 2.95	1.25	0.48 to 3.24	21	1.25	0.48 to 3.24

Continued

Table 3 Continued

	N	Overall mortality		CV mortality		AC mortality				
		Deaths	HR	95% CI	Deaths	HR	95% CI	Deaths	HR	95% CI
Other service activities	4939	211	1.18	0.75 to 1.85	46	0.94	0.33 to 2.68	18	2.33	0.73 to 7.4
Domestic services	4042	226	0.43	0.22 to 0.84	59	0.54	0.17 to 1.73	8	-	-

Men 2001–2015.
 *International organisations sector, contributing with 94 and 35 deaths for men and women respectively, was not shown.
 AC, accidental; CV, cardiovascular; HR, adjusted for age.

contracts (manual: HR 1.16; 95% CI 1.05 to 1.28; sale or service: HR 1.22; 95% CI 1.02 to 1.46). However, it should be noted that HRs>1 were found in all occupational classes, although without reaching statistical significance. Furthermore, high-skill non-manual workers with temporary contracts showed significantly higher cardiovascular mortality compared with high-skill non-manual workers with permanent contracts (HR 1.34; 95% CI 1.06 to 1.70).

DISCUSSION

Our results, based on a cohort of 597 834 employees, showed that having temporary contracts, compared with permanent ones, was associated with greater overall mortality risk in men but not in women. Mortality risks for temporary employees compared with permanent ones varied widely among different economic sectors. In men, we found higher risks in the industry, building constructions and social services sectors. In women, we found a higher risk in temporary compared with permanent workers only in sales and transports, mainly due to the strong association in the retail sector.

Differences between men and women were consistent for all considered causes of death and all economic sectors, except for sales and transport. There was considerable agreement between our results and previously published works regarding gender differences in the association between temporary contracts and mortality. All the studies that stratified the analysis by gender found stronger associations in men than in women.^{11–13}

For both men and women, the analysis of the association between temporary contracts and mortality by sector of employment showed that most HRs were greater than one. The risk for temporary employment was generally higher in sectors where less-skilled employees were more represented. Particularly in men, mortality was higher in sectors in which manual workers are predominant, such as industry and building constructions. One possible explanation could be that temporary workers employed in these sectors might be exposed to specific risks. Indeed, it is well known that employees working in specific economic sectors may be exposed to hazards and behavioural risks.^{20 21} Furthermore, it is well established that, compared with permanent workers, temporary ones experience worse job quality,²² and less use of personal protective equipment,²³ as well as less training and information about the work environment and occupational risks.^{24 25} Therefore, it could be hypothesised that these conditions impact mostly on temporary workers employed in specific sectors. In men, the association between temporary contracts and mortality was also evident in the sector of public administration. This association is somewhat difficult to explain. It has to be considered that, due to the high number of comparisons, it could be possible that some of the associations can be due to chance.

A study conducted in Rome that analysed the association between occupational status and mortality found higher



mortality for cardiovascular disease and accidental causes in unemployed compared with employees.¹⁷ Possible explanations provided by the authors are the prevalence of risky behaviours and habits (smoking or unhealthy diet) among the unemployed and the 'status syndrome' theory that hypothesises a link between lack of control and low social participation and disease risk. Temporary workers may share some of the same risky conditions of unemployed. A study found higher mortality in temporary compared with permanent workers for smoking and alcohol-related cancers.¹³ Furthermore, temporary workers can frequently experience periods of unemployment. Therefore, some of the risk factors of unemployment may have an impact also on temporary employment regarding cardiovascular and accidental mortality.

In general, temporary employment includes all forms of no open-ended contracts, such as fixed-term, temporary-agency, apprenticeship, seasonal and casual works. Most of these forms of contracts may share different dimensions of precariousness, such as job insecurity, low wages and social protection. These factors are proposed as possible pathways linking temporary employment to adverse health outcomes.²⁶ Nevertheless, a negative impact was generally found on self-reported health,^{2 27} although some studies are not consistent with this result.²⁸ There is a large consensus regarding the negative impact on mental health,¹⁰ while for occupational injuries, a recent meta-analysis showed no conclusive results.²⁹ Studies on mortality showed that the strength of the association varies with the type of temporary contract,¹¹ and that the risk is higher only for involuntary and not satisfied temporary workers.¹⁴

It should be considered that type of contract might partly reflect the well-known health differences in occupational class. However, the additional analysis showed differences for both manual and high-skill non-manual workers. Therefore, temporary contracts and job type seem to assess distinct socioeconomic job-related domains, with temporary contracts showing different impacts on mortality risk among the occupational classes.

Globally, the studies on the association between temporary employment and mortality are limited, and they were all conducted in North European countries. It is noteworthy that the impact of precariousness on health outcomes could also depend on contextual factors, such as the percentage of precarious employment and the social policies in the country.³⁰ Our study was the first to analyse the association between mortality and type of contract in Italy. According to the Italian Institute of Statistics, the percentage of temporary employment in Italy has increased in the last decades, ranging from a mean of 11.8% of the total dependent employee in 2004 to a mean of 17.0% in 2019.³¹ Rising in temporary contracts was mainly explained by the structural reforms that increased flexibility in the labour market over the last decades,³² as well as the Great Recession in 2008. Regarding gender differences in contracts type, our data based on Rome population agree with national data, with

a higher rate of temporary workers in women than in men. In the population of Rome, the higher percentage of women with temporary contracts in our study can be added to previous results showing that women had a higher rate of unemployment than men.¹⁷

Our study had some limitations. First, the type of contract was evaluated only at the beginning of the follow-up, that is, 2001. However, there is substantial agreement between the principal and the sensitivity analyses, although the smaller number of deaths in the latter reduced the significance of the associations. Second, there was a lack of information on employees' health and behavioural risk factors. In particular, it is possible that the health status influenced the probability of having permanent employment, determining a selection bias. Another potential selection bias could be the differential migration from Rome in temporary versus permanent workers. However, assuming the absence of unmeasured confounders, we used an inverse probability weighting approach to handle missing information on deaths due to lost to follow-up due to migration, obtaining weighted HRs similar to those presented. Finally, since the cohort was followed from 2001 to 2015, the data could be considered dated. However, the 2001 census was the last census that collected information on jobs and type of contracts for the whole population. Therefore, it is the last census that allows analysing different economic sectors separately.

In conclusion, our results point out that temporary contracts should be considered as an important determinant of health, in particular for workers employed in specific economic sectors. At the health and work policy level, this means that major efforts should be made to reduce precariousness. As a determinant of health, temporary work should be taken into account also in the development of national and local prevention plans, providing specific sector recommendations for both employers and occupational medicine professionals. Prevention strategies, such as information and training, should also be implemented.

The well-known heterogeneity in the temporary employees was confirmed by our study throughout the different economic sectors. These results highlight the importance of performing studies on health outcomes in temporary workers focusing on various economic sectors to understand better individual, work-related and contextual factors linking temporary contracts and mortality risk. Future research should confirm these results and evaluate differences among countries with different labour market settings.

Contributors AN and GC conceived the study, drafted the manuscript and were responsible for the final version of the manuscript. GC handled the permissions, the data collection, and was the guarantor of the study. AN, LDB and GC handled the data management and analyses. NA and MD critically revised the manuscript for important intellectual content. All authors reviewed, read and approved the final manuscript.

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Data availability statement Data may be obtained from a third party and are not publicly available. Data reported in the manuscript are not publicly available because of stringent legal restrictions regarding privacy policy on personal information in Italy (national legislative decree on privacy policy n. 196/30 June 2003). All data presented in the study are stored by the Department of Epidemiology-Lazio Regional Health Service and only the research team and related Institutions have access to the data. Interested researchers can contact the following persons to request aggregated data: Nera Agabiti (n.agabiti@deplazio.it) and Damiano Lanzi (d.lanzi@deplazio.it)

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Supplemental Material

Differences in mortality between temporary and permanent workers: results from the Rome Longitudinal Study.

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Supplementary Table 1. Characteristics by occupational sector in men, Rome 2001.

Men	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Fishing and agriculture	3,927	14.7	7.6	9.8	43.7 (10.9)	271	24.7	7.0
Agriculture, hunting, forestry	3620	14.9	7.5	9.6	44.0 (10.9)	250	26.0	6.8
Fishing, fish farming	307	12.4	8.1	11.4	40.9 (10.6)	21	9.5*	9.5*
Industry	44,568	9.7	18.2	4.8	42 (9.9)	1,897	26.5	6.9
Coal mining, oil extraction	1,829	6.2	29.3	4.6	45.7 (10)	86	24.4	4.7*
Food industry	3,979	10.0	12.0	5.2	41.7 (9.9)	171	26.9	7.6
Textile, leather industry	2,035	14.3	9.0	7.4	41.3 (10.5)	107	33.6	4.7*
Wood, wood products industry. publishing	5,174	9.5	9.2	3.6	42.2 (9.5)	225	28.0	4.4
Refinery, pharmaceutical, chemical industry	5,959	8.8	35.1	4.9	42.5 (9.8)	211	25.1	6.6
Non-metal mineral industry	1,348	13.8	7.8	7.6	41.5 (10.2)	71	38.0	5.6*
Steel industry	17,755	10.6	17.8	4.8	41.1 (9.8)	728	25.7	8.8
Furniture industry	1,651	13.3	6.8	7.6	41.1 (10.8)	89	18.0	5.6*
Production, distribution of electricity, water and gas	4,838	4.9	19.6	2.6	44 (9)	209	25.4	5.3
Building Constructions	21,058	14.2	10.2	7.1	41.5 (10.7)	1,047	27.7	8.2
Sales and Transport	79,626	11.0	9.4	5.6	41.1 (10.1)	3,265	26.3	6.9
Sale, maintenance, repair of motor vehicles, sale of fuel	8,449	11.6	6.1	4.8	40.3 (10.3)	345	22.3	5.8
Wholesale trade, intermediaries of trade	7,795	11.4	8.4	5.2	39.9 (10)	261	25.3	6.1
Retail trade	13,546	13.0	5.9	5.1	39.4 (10.4)	547	23.8	7.3
Hotels, camping, bars, restaurants	13,147	13.8	4.8	13.5	39.5 (10.2)	561	27.5	9.1
Transport	36,689	9.1	13.4	3.2	42.7 (9.8)	1,551	27.9	6.3
Credit, insurances and other services	51,771	9.2	32.4	3.1	41 (9.9)	1,806	26.4	4.9
Credit, insurance, monetary, financial intermediation	23,179	4.6	29.5	2.6	45 (9.3)	1,059	25.0	4.6
IT, research, development	18,870	11.4	35.0	3.0	36.9 (8.6)	383	29.8	5.7
Professional consulting, real estate, rental	9,722	15.6	34.1	4.4	39.1 (10.1)	364	26.6	4.7
Social services	117,812	7.8	29.7	4.2	44.2 (9.9)	5,910	26.6	5.6

Supplementary Table 1. *Continued*

	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Local, national, public administration	66,677	4.5	21.0	2.7	44 (9.8)	3,245	27.1	5.4
Public, private education	15,276	11.6	62.9	4.3	47.3 (9.6)	897	25.6	4.8
Health, social assistance	19,331	8.5	45.7	3.3	44.7 (9.4)	1,003	27.6	6.2
Political, trade union organizations	2,404	11.9	35.9	3.0	43.9 (10)	111	29.7	2.7*
Recreational, cultural, sports activities	5,143	27.1	22.8	5.5	41 (10)	217	22.6	9.7
Other service activities	4,939	12.2	5.5	4.9	40.3 (9.8)	211	21.8	8.5
Domestic services	4,042	11.5	4.9	32.1	42.9 (10.1)	226	26.1	3.5*
International organizations	1,892	12.2	32.2	20.6	44.7 (9.9)	94	27.7	7.4*

* Less than 10 deaths

CV cardiovascular

AC accidental

Supplementary Table 2. Characteristics by occupational sector in women, Rome 2001.

Women	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Fishing and agriculture	3,032	20.4	8.4	12.0	43.7 (10.3)	114	23.7	0.9*
Agriculture, haunting, forestry	2,917	20.3	7.9	12.2	43.9 (10.2)	113	24.0	0.9*
Fishing, fish farming	115	25.2	20.9	6.1	40.1 (10.9)	1	0.0	0.0
Industry	19,721	13.9	18.9	7.3	39.8 (9.4)	423	16.5	5.7
Coal mining, oil extraction	964	9.2	20.4	4.9	43 (9)	19	5.3*	0.0
Food industry	1,797	15.2	13.5	9.1	39.4 (9.9)	36	25.0*	11.1*
Textile, leather industry	3,553	18.7	6.3	9.8	40.1 (10.1)	96	16.7	4.2*
Wood, wood products industry, publishing	2,313	13.1	17.8	4.5	40.2 (9)	47	12.8*	4.3*
Refinery, pharmaceutical, chemical industry	3,360	13.0	37.6	7.2	38.6 (8.7)	61	21.3	9.8*
Non-metal mineral industry	393	16.5	13.0	11.2	39.3 (9.7)	13	0.0	15.4*
Steel industry	5,137	14.0	17.9	7.3	39.5 (9.3)	105	15.2	3.8*
Furniture industry	583	17.5	10.5	9.3	38.2 (9.6)	12	16.7*	8.3*
Production, distribution of electricity, water and gas	1,621	5.6	22.2	3.8	41.6 (8.6)	34	20.6*	2.9*
Building Constructions	3,612	14.3	15.9	4.1	38 (9)	74	16.2	4.1*
Sales and Transport	51,334	14.6	11.9	5.7	38.3 (9.5)	980	13.5	4.7
Sale, maintenance, repair of motor vehicles, sale of fuel	3,241	14.9	10.9	4.4	38.2 (9.5)	68	7.4*	5.9*
Wholesale trade, intermediaries of trade	5,755	13.3	9.6	5.3	37.7 (9.1)	105	16.2	5.7*
Retail trade	16,323	15.9	6.8	5.3	37.8 (9.9)	317	14.2	4.4
Hotels, camping, bars, restaurants	10,361	16.8	5.5	8.6	38.4 (9.8)	215	15.3	5.1
transport	15,654	12.0	22.6	4.7	39 (9.1)	275	11.6	4.0
Credit, insurances and other services	42,745	14.0	25.6	3.9	37.6 (8.8)	727	12.2	4.5
Credit, insurance, monetary, financial intermediation	16,469	8.3	23.2	3.6	40.4 (8.8)	359	13.1	3.1
IT, research, development	10,517	16.5	37.6	3.5	35.2 (7.5)	134	8.2	6.0*
Professional consulting, real estate, rental	15,759	18.2	20.1	4.4	36.4 (8.7)	234	13.2	6.0
Social services	154,755	12.5	33.0	6.3	43.3 (9.3)	4,493	14.8	3.4

Supplementary Table 1. Continued

	N	Contract (% Temporary)	Education (% High)	Place of birth (% Abroad)	Age mean (sd)	Number of deaths	% CV deaths	% AC deaths
Local, national, public administration	54,091	5.9	25.3	3.1	44.3 (8.6)	1,676	15.0	4.3
Public, private education	45,229	16.7	50.8	4.6	45.2 (9.2)	1,416	13.4	2.5
Health, social assistance	31,890	11.7	34.2	4.8	41.3 (9.3)	832	14.9	3.7
Political, trade union organizations	3,618	12.9	25.4	3.9	40.9 (9)	87	17.2	1.1*
Recreational, cultural, sports activities	5,433	31.2	31.9	6.0	38.8 (9.4)	117	9.4	4.3*
Other service activities	5,473	17.3	6.4	5.4	37.9 (9.9)	127	18.1	2.4*
Domestic services	9,021	18.8	5.5	40.4	42.4 (10.1)	238	21.0	3.4*
International organizations	1,981	17.6	41.5	39.0	43.6 (9.4)	35	5.7*	0.0

* Less than 10 deaths

CV cardiovascular

AC accidental

Table S3. Association between temporary employment and mortality in men and women. Rome 2001-2015

	Men									Women								
	Overall mortality			CV mortality			AC mortality			Overall mortality			CV mortality			AC mortality		
	HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI		HR	95% CI	
HR adjusted for age and level of education																		
Overall	1.13	1.06	1.20	1.25	1.11	1.41	1.31	1.06	1.61	1.01	0.93	1.10	0.97	0.77	1.22	1.35	0.95	1.93
Sector of employment*																		
Fishing and agriculture	0.85	0.57	1.25	1.33	0.68	2.59	1.02	0.28	3.69	0.67	0.39	1.18	0.47	0.14	1.57	-	-	-
Industry	1.21	1.02	1.42	1.11	0.80	1.54	1.61	0.98	2.64	0.98	0.71	1.36	1.52	0.76	3.05	2.19	0.80	6.02
Building Constructions	1.23	1.03	1.46	1.22	0.87	1.70	1.21	0.69	2.14	0.91	0.37	2.22	4.79	0.83	27.5	-	-	-
Sales and Transport	1.08	0.95	1.23	1.27	1.00	1.61	1.10	0.74	1.64	1.23	1.01	1.50	1.29	0.77	2.13	1.53	0.70	3.37
Credit, insurances and other services	1.09	0.88	1.35	1.20	0.79	1.81	0.98	0.43	2.24	0.88	0.67	1.17	0.80	0.34	1.88	0.96	0.31	2.90
Social services	1.13	1.01	1.26	1.29	1.05	1.59	1.38	0.95	2.00	0.99	0.89	1.11	0.82	0.60	1.13	1.27	0.78	2.06
HR adjusted for age, level of education, and place of birth																		
Overall	1.13	1.06	1.21	1.25	1.11	1.42	1.31	1.07	1.61	1.02	0.93	1.11	0.96	0.77	1.21	1.36	0.96	1.94
Sector of employment*																		
Fishing and agriculture	0.94	0.62	1.40	1.54	0.77	3.09	1.08	0.27	4.34	0.78	0.44	1.37	0.54	0.16	1.83	-	-	-
Industry	1.21	1.03	1.43	1.09	0.78	1.52	1.65	1.00	2.72	0.98	0.71	1.37	1.51	0.73	3.11	1.95	0.69	5.57
Building Constructions	1.22	1.02	1.46	1.20	0.85	1.69	1.26	0.71	2.24	1.12	0.42	3.01	3.95	0.58	27.1	-	-	-
Sales and Transport	1.08	0.95	1.23	1.27	1.00	1.61	1.10	0.74	1.64	1.24	1.02	1.51	1.28	0.77	2.14	1.54	0.70	3.41
Credit, insurances and other services	1.11	0.89	1.38	1.23	0.81	1.86	1.00	0.44	2.28	0.91	0.68	1.20	0.89	0.38	2.10	0.96	0.31	2.92
Social services	1.13	1.01	1.27	1.30	1.06	1.60	1.39	0.96	2.02	0.99	0.89	1.11	0.82	0.59	1.12	1.27	0.78	2.07

CV cardiovascular

AC accidental

*Sum of macro-sectors differs from the overall population because the international organizations sector, contributing with 94 and 35 deaths for men and women respectively, was not showed.

Table S4. Association between temporary employment and mortality in men and women. Rome, 2001-2006

	N			Overall mortality			N			CV mortality			N			AC mortality		
	deaths	HR	95% CI	deaths	HR	95% CI	deaths	HR	95% CI	deaths	HR	95% CI	deaths	HR	95% CI	deaths	HR	95% CI
Men																		
Overall	3,657	1.13	1.00	1.28	1,003	1.31	1.04	1.65	345	1.11	0.79	1.56						
Sector of employment*																		
Fishing and agriculture	66	1.40	0.72	2.69	14	3.25	1.00	10.6	6	1.12	0.13	10.03						
Industry	477	1.18	0.85	1.63	161	1.40	0.82	2.37	52	1.12	0.48	2.61						
Building Constructions	297	1.14	0.81	1.61	90	1.31	0.73	2.38	36	1.13	0.46	2.75						
Sales and Transport	836	1.16	0.90	1.48	230	1.25	0.79	2.00	91	0.90	0.47	1.75						
Credit, insurances and other services	439	1.42	0.96	2.09	110	2.07	1.03	4.14	37	1.41	0.50	4.00						
Social services	1,517	0.92	0.73	1.17	391	0.85	0.52	1.39	122	1.01	0.52	1.97						
Women																		
Overall	1,638	1.01	0.84	1.20	222	1.16	0.74	1.83	94	1.61	0.93	2.77						
Sector of employment*																		
Fishing and agriculture	33	0.95	0.39	2.35	5	-	-	-	1	-	-	-						
Industry	100	0.86	0.43	1.71	14	1.70	0.37	7.68	12	0.70	0.09	5.52						
Building Constructions	19	1.31	0.29	5.94	2	16.8	1.03	274.5	-	-	-	-						
Sales and Transport	245	1.38	0.95	2.00	36	1.05	0.37	3.02	14	2.31	0.63	8.43						
Credit, insurances and other services	175	0.82	0.46	1.46	20	1.84	0.51	6.63	16	0.48	0.06	3.83						
Social services	1,060	0.93	0.73	1.18	145	1.02	0.55	1.91	51	1.93	0.95	3.95						

HR adjusted for age

CV cardiovascular

AC accidental

*Sum of macro-sectors differs from the overall population because the international organizations sector, contributing with 94 and 35 deaths for men and women respectively, was not showed.

Table S5. Association between temporary employment and mortality by sex and type of work, Rome 2001-2015

	Overall mortality					CV mortality				AC mortality			
	N	Deaths	HR	95% CI		Deaths	HR	95% CI		Deaths	HR	95% CI	
Men													
Overall	320,654	14,290	1.16	1.09	1.24	3,793	1.29	1.14	1.45	884	1.27	1.04	1.57
High-skill non manual	86,759	3,826	1.05	0.92	1.20	1,019	1.34	1.06	1.70	197	1.19	0.73	1.94
Low-skill non manual	94,764	3,989	1.14	0.99	1.31	1,037	1.15	0.88	1.51	244	1.37	0.89	2.11
Sales	37,183	1,452	1.22	1.02	1.46	367	1.33	0.94	1.89	115	1.75	1.07	2.87
Manual	86,555	4,646	1.16	1.05	1.28	1,273	1.24	1.03	1.50	296	1.22	0.88	1.69
Women													
Overall	277,180	6,846	1.03	0.95	1.12	997	1.02	0.81	1.28	262	1.34	0.94	1.91
High-skill non manual	61,000	1,502	0.97	0.80	1.19	188	1.22	0.72	2.10	45	1.72	0.75	3.97
Low-skill non manual	142,773	3,358	1.07	0.94	1.22	455	0.82	0.55	1.24	127	1.04	0.57	1.87
Sales	35,679	757	1.03	0.82	1.30	124	0.97	0.54	1.72	41	1.75	0.82	3.75
Manual	37,668	1,228	0.95	0.80	1.13	230	1.04	0.70	1.54	49	1.28	0.62	2.65

HR adjusted for age

CV cardiovascular

AC accidental