Ann Ist Super Sanità 2020 | Vol. 56, No. 3: 267-276
DOI: 10.4415/ANN_20_03_04

Demographic and socio-economic determinants of poor HIV-risk perception at first HIV diagnosis: analysis of the HIV Surveillance data, Italy 2010-2016

Maria Dorrucci[1], Vincenza Regine[1], Patrizio Pezzotti[1], Alessia Mammone[2], Enrico Girardi[2], Barbara Suligoi[1] and the HIV Surveillance System Group*

[1]Dipartimento di Malattie Infettive, Istituto Superiore di Sanità, Rome, Italy
[2]Istituto Nazionale Malattie Infettive "L. Spallanzani", Rome, Italy
**The members of the HIV Surveillance System Group are listed before the References*

Abstract

Introduction. HIV infections in Italy has not undergone a substantial decline over recent years. For this reason, we analysed risk-factors and socio-economic indicators of HIV-risk perception in HIV surveillance data.

Methods. An observational study was conducted and HIV-risk perception was estimated on the basis of reasons for undergoing testing. Ordinal logistic models were applied with three groups of response corresponding to three ordered levels of HIV-risk perception.

Results. The study included 18 055 individuals: 27% with low, 40% moderate and 33% with high perception. A low risk perception was estimated in both areas, least deprived and highly deprived [Adjusted Odds Ratio (AOR) = 1.58, CI: 1.14-2.18 and AOR = 2.33, CI: 1.39-3.90]; for heterosexuals (AOR = 1.96, CI: 1.83-2.11), Injecting Drug Users (IDU) (AOR =1.82, CI: 1.59-2.08), low education (AOR = 1.74. CI: 1.20-2.54), age > 40 years (AOR = 1.59, CI: 1.50-1.69), males (AOR = 1.30, CI: 1.20-1.40).

Conclusions. In Italy there is a high percentage of HIV-infected people with poor HIV-risk perception. Poorer HIV-risk perception was associated with both, least and high deprivation, low education, older age, male gender, heterosexual and IDU groups. Our results could be relevant to address targeted HIV testing policies at both local and national levels.

Key words
- epidemiology
- HIV
- risk-perception

INTRODUCTION

The trend of new diagnoses of HIV infections in Italy has not undergone a substantial decline over recent years. The Italian HIV-Surveillance System (IHIVS) was established in July 2008 [1], and it has been reporting about 4000 new HIV diagnoses every year [2, 3]. It has also been estimated that nearly 13% of people living with HIV was still undiagnosed, most likely because they were unaware of HIV-positive status [4]. In Italy, roughly 40-60% of HIV-positive people are diagnosed at a late stage of infection [5], as well as in rest of Europe [6]. Further, these proportions did not change substantially since 2010 [7].

The stable trend of new HIV diagnoses and the high percentage of those diagnosed with low CD4 or at AIDS stage may be due to poor "HIV-risk perception". This term can involve a number of factors, including the personal perception of a low spread of HIV infection: the notion, for instance, that HIV is no longer a health problem thanks to antiviral treatment, the belief of not belonging to a risk group, as well as the fear associated with the stigma related to a positive diagnosis [8]. All these factors could determine, consequently, a strong delay in HIV-testing.

The importance of estimating individual HIV-risk perception mainly relies on its possible effect on decision to opt for testing. Several studies have been conducted [9-13] on possible association between HIV-testing and HIV-perception. However, these studies reported contrasting results. A study from UK showed

Address for correspondence: Maria Dorrucci, Dipartimento di Malattie Infettive, Istituto Superiore di Sanità, Viale Regina Elena 299, 00161 Rome, Italy. E-mail: maria.dorucci@iss.it.

that only a minority of those who perceived themselves to be at high risk of HIV was tested in the previous year [14]. In other studies, conversely, there is evidence that greater HIV-risk perception is related to subsequently HIV testing [15-18]. Thus, it is crucial to confirm and explore more about possible risk factors and/or determinants associated with HIV-risk perception to address targeted HIV testing policies at both local and national levels.

To our knowledge only one study on risk factors associated with HIV-risk perception [14] was published considering the general population, while no studies were conducted on HIV-risk perception using HIV-surveillance data. For these reasons, we performed a study in Italy with the aim of analyzing risk-factors and socio-economic indicators of HIV-risk perception using the Italian HIV-Surveillance System (IHVS).

METHODS

Study design and population

Observational study by using Italian HIV Surveillance System (IHIVS) [1].

In particular, we considered all new HIV diagnoses aged 18-85 reported to the Italian HIV-Surveillance System (IHIVS) between 2010 and 2016; this surveillance system has a national coverage and is continuously fed by approximately 180 infectious disease clinics located in all the 20 Italian regions. All diagnoses included in the present analysis were notified within the end of 2016. We did not consider the years before 2010 given that the national surveillance system reached 100% territorial coverage only in 2010 [3]. The surveillance system collects the following information: demographic characteristics, clinical data (CD4 cell count, viral load, clinical stages) and reason for HIV testing. Diagnoses that did not report the reason for HIV testing or lacking demographical were excluded (nearly 30%).

Definition of HIV-risk perception

Reason for HIV testing was used as a proxy of HIV-risk perception: the reason for undergoing HIV-testing was an open question, and the answer was collected by the clinician at first HIV diagnosis. Only one reason was to be provided. Thus, reason for HIV-testing was classified in three groups, from the lowest to the highest risk perception as follows:

1) HIV-related symptoms; 2) check-up for diseases other than HIV; 3) having engaged in behaviour at risk for HIV (i.e., unprotected sex).

In order to verify if the given order of the three groups could be reasonable from the lowest to the highest, we studied the association between CD4 at HIV diagnosis and the above mentioned groups (details in statistical analysis).

Demographic and socio-economic covariates

Individual characteristics from newly diagnosed HIV-positive individuals deemed as possible covariates associated to different levels of risk-perception were: age at first diagnosis (aged > 40 *vs* ≤ 40); gender (males *vs* females); HIV- risk category (heterosexuals, injecting drug users, IDU), not indicated *vs* men who have sex with men, MSM); nationality (Italian *vs* non-Italian); geographical area of residence (regions grouped on the basis of geographic area and classified by the Italian Statistics Institute (ISTAT) as: Northern (i.e., Piemonte, Valle d'Aosta, Liguria, Lombardia, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia- Romagna), Central (i.e., Toscana, Umbria, Marche, Lazio), Southern (i.e., Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia, Sardegna); year of the first HIV diagnosis (grouped as 2010-2015 and 2016).

The study also analyzed socio-economic indicators estimated each year by ISTAT [19] and used by Eurostat [20, 21]. The socio-economic indicators are derived from indicators database collected by ISTAT at National level which includes 316 indicators available at regional level [19]. The values of the indicators are based on data from the 2011 Italian population census; we considered in our analysis two regional indicators: education and deprivation [19]. For the present study we considered the estimates in 2013, i.e. the central year of the study period (2010-2016).

In particular, the Education indicator reports the percentage of adults per each Italian region, who have attained at most a lower secondary education level (i.e., at least 8 years of studies) according to the International Standard Classification of Education (ISCED level 2) [22]; the deprivation indicator (named "severe material deprivation rate") is an indicator that "directly considers the lack of some goods and services which are considered essential for a decent life"; more specifically, it was estimated on the basis of percentage of families who say at least three of nine deprivations such as, unable to sustain unforeseen expenses, a proper meal (i.e., protein) at least once every two days, adequate heating the home [20].

In our study we assigned the regional estimates (corresponding to the 20 Italian regions) both Education indicator and the Deprivation to the individual provinces of residence: the provinces are smaller Italian areas within regions (107 provinces overall with a mean of 5-6 provinces in each region). Thus, we divided the study population in tertiles in order to obtain groups of similar sizes.

Statistical analysis

As first analysis we performed a graph of the box-plot according to HIV-risk perception level, and then we applied a ordinal logistic model with the three groups of response corresponding to the three ordered levels of HIV-risk perception, from the lowest to the highest risk perception as already mentioned in the definition of HIV-risk perception paragraph. This just mentioned analysis was performed in order to verify the previously discussed classification orderings. Thus, we assumed that, on average, the lower was the CD4 count at new diagnosis the lower the HIV-risk perception.

Then we applied ordinal logistic models [22], with the three groups of response corresponding to the three ordered levels of HIV-risk perception, from the lowest to the highest risk perception (see definition of HIV-risk perception).

Firstly, we performed the univariate analyses using

ordinal logistic models, thus estimating the crude Odds Ratio (OR) for each of independent variables as well as for each indicator (education and deprivation). Secondly, we applied multilevel ordinal logistic regression models [23] using individual characteristics at the first level (age, gender, HIV-risk groups, nationality, area of residence, year of diagnosis), and the level of deprivation and education at the second level (107 provinces within regions), as we already mentioned in describing these covariates. The between-provinces of residence variance (i.e., random intercept) was estimated for all multilevel models. It was regarded as significant when the p-value was < 0.001, indicating that there was a very significant amount of variability in the odds of HIV-risk perception between provinces within geographical regions of residence [24].

All analyses were applied using SAS statistical software version 9.4.

RESULTS

Characteristics of the study population

From 2010 through 2016, 26 434 new HIV diagnoses among adults were reported to the IHIVS. Of these, we excluded 6557 (25% of the total diagnoses) diagnoses with reason for HIV testing not indicated, and 1822 (7%) individuals without demographic data. The studied population, therefore, consisted on 18 055 new HIV diagnoses (i.e., nearly the 70% of the total diagnoses from 2010 to 2016).

The characteristics of the study population (n = 18 055) are summarized in *Table 1*, the median age of the study participants was 39 yrs with 56% aged less than 40 yrs. Further, more than 70% were males and of Italian nationality. Heterosexuals were 46%, followed by MSM (40%). The majority of diagnoses (more than 60%) were performed among those resident in Northern Italy; almost a constant number of new HIV diagnoses were observed each year in the study period (i.e., about 14% each year).

The tertiles (roughly 33% of new diagnoses) of education and deprivation at regional level are also shown in *Table 1*. The majority was included into regions with moderate level of education, i.e. they lived in regions with education level equal to 40%-41%; whilst the 37% lived in least deprived regions, i.e. in regions with a deprivation level up to a maximum of 14%.

The general characteristics of the study population, shown in *Table 1*, were almost similar to that of the target population, i.e., all HIV diagnoses from 2010 to 2016 with the only exception of not indicated HIV exposure group that was more frequent among individuals excluded (22%) compared to 8% of those included in the studied population. Further, the majority (about the 60%) of missing data comes from only one region in Central Italy.

Table 1
General characteristics and socio-economic indicators at diagnosis (n = 18 055 new HIV diagnoses, Italy 2010-2016)

Age	
median	39 yrs
IQR; range	(31-47); (18-86) yrs
age < 40	
age ≥ 40	
Gender	
males	13 986 (77%)
females	4069 (23%)
HIV-exposure category	
heterosexuals	8379 (46%)
MSM	7221 (40%)
IDU	838 (5%)
not indicated	1617 (9%)
Nationality	
Italians	13 370 (74%)
non-Italians	4685 (26%)
Geographical area	
Northern Italy	11 364 (63%)
Central Italy	2604 (14%)
Southern Italy	4087 (23%)
Year of diagnosis	
2010	2518 (14%)
2011	2640 (14%)
2012	2931 (16%)
2013	2664 (15%)
2014	2473 (14%)
2015	2491 (14%)
2016	2338 (13%)
Education, tertiles[1]	
least level: 33%-39%	3971 (22%)
moderate level: 40%-41%	8328 (46%)
high level: 42%-52%	5756 (32%)
Deprivation, tertiles[2]	
least level: 8%-14%	6749 (37%)
moderate level: 15%-16%	5589 (31%)
high level: 17%-43%	5717 (32%)

[1]We assumed as least educated, individuals living in regions with an education level ranging from 33% to 39% i.e., the "rate" of adults with a lower secondary education level ranging from 33% to 39%, as moderate level from 40% to 41%, and as high level from 42% to 52%. [2]We assumed as least deprived, individuals living in regions with a percentage of families with material deprivation from 8% to 14%, as moderate level from15% to 16%, and high level from 17% to 43%.

Association between HIV-risk perception and CD4 at first diagnosis

A lower CD4 count was observed according to the level of HIV-risk perception as shown by the box-plots of CD4 in *Figure 1*. Further, in *Figure 2* is shown the probability of each of the three groups wherewith we defined HIV-risk perception within CD4 categories: the lowest CD4 (< 200 cells/mm^3) was mostly associated when reason for testing was 1 ("because HIV-symptoms"), reason for testing = 2 ("check-up for diseases other than HIV") mostly was associated with

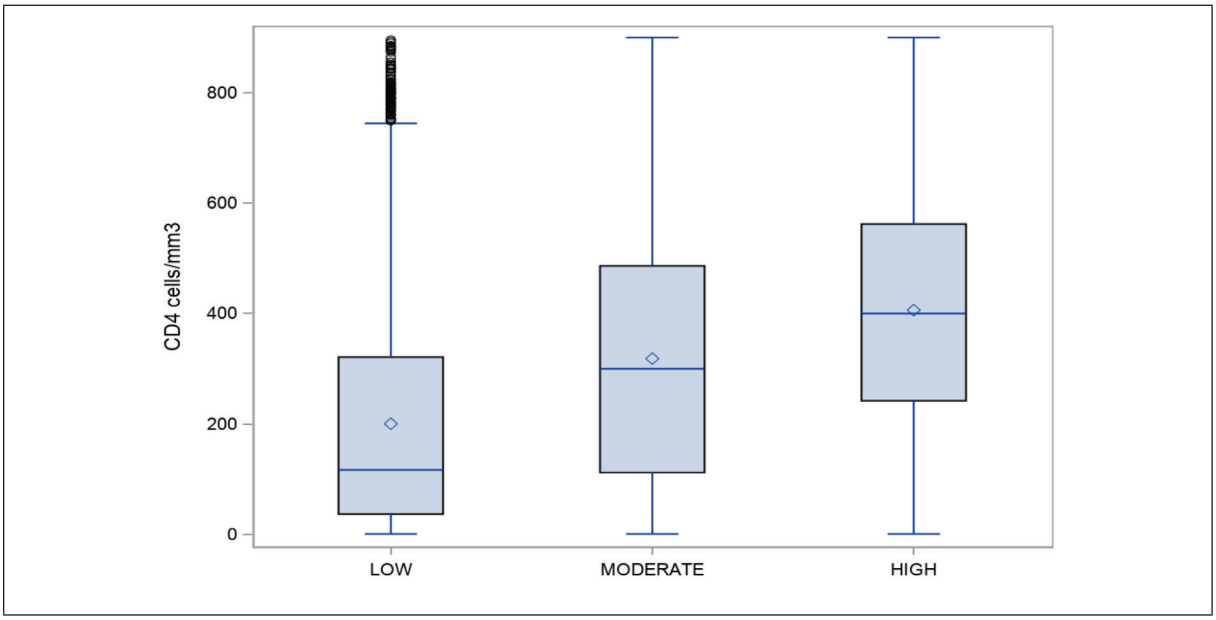

Figure 1
Box-plots of CD4 count according to level of HIV-risk perception at new diagnosis ; HIV-risk perception: LOW = "because HIV-symptoms", MODERATE = "check-up for diseases other than HIV", HIGH = "having engaged in behaviour at risk for HIV"; see methods, definition of HIV-risk perception.

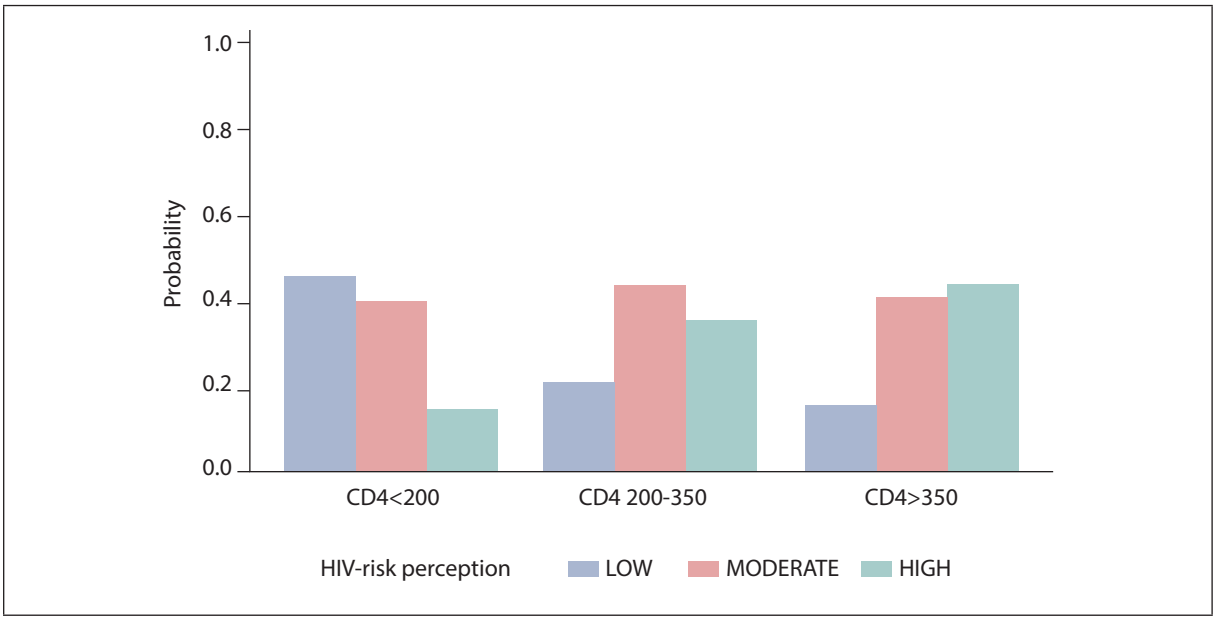

Figure 2
Probability estimated by ordinal logistic model of each HIV-risk perception level within CD4 category HIV-risk perception: LOW = "because HIV-symptoms", MODERATE = "check-up for diseases other than HIV", HIGH = "having engaged in behaviour at risk for HIV"; see methods, definition of HIV-risk perception.

CD4 from 201 to 350 cells/mm3, the reason for testing = 3 ("having engaged in behavior at risk for HIV") mostly was associated with CD4 > 350 cells/mm3, which confirms the previously discussed classification orderings, i.e. assuming that those with the poorest HIV-risk perception were those reporting mostly lower CD4 at first diagnosis (see methods, definition of HIV-risk perception).

HIV-risk perception in the Italian Surveillance (IHIVS)

Table 2 shows the main characteristics of the study population by HIV-risk perception stratified by the individual characteristics and regional socio-economic indicators: 4804 (27%), 7327 (40%), and 5924 (33%) were classified from the poorest to the highest HIV-risk perception, respectively.

Table 2
General characteristics and socio-economic indicators at diagnosis according the level of HIV-risk perception (low, moderate, high; n = 18 055 new HIV diagnoses, Italy 2010-2016)

	Low[1] n = 4804 (27%)		Moderate[2] n = 7327 (40%)		High[3] n = 5924 (33%)	
	n	%	n	%	n	%
Age						
<40	2135	44%	4278	58%	3705	63%
≥40	2669	56%	3049	42%	2219	37%
Gender						
males	3828	80%	5345	73%	4813	81%
females	976	20%	1982	27%	1111	19%
HIV exposure category						
heterosexuals	2483	52%	3706	51%	2190	37%
IDU	225	5%	424	6%	189	3%
MSM	1621	34%	2423	33%	3177	54%
not indicated	475	9%	774	11%	368	6%
Nationality						
Italians	3587	27%	5232	39%	4551	34%
non-Italians	1217	26%	2095	45%	1373	29%
Geographical area						
Northern Italy	2276	20%	5167	70%	3921	66%
Central Italy	1297	50%	547	8%	760	13%
Southern Italy	1231	30%	1613	22%	1243	21%
Year of diagnosis						
2010	632	13%	1041	14%	845	14%
2011	697	14%	1026	14%	917	15%
2012	785	16%	1159	16%	987	17%
2013	715	15%	1081	15%	868	15%
2014	690	14%	941	13%	842	14%
2015	657	14%	1089	15%	745	13%
2016	628	14%	990	13%	720	12%
Education, tertiles[4]						
least level: 33%-39%	1923	40%	832	11%	1216	21%
moderate level: 40%-41%	904	19%	4495	61%	2929	49%
high level: 42%-52%	1977	41%	2000	28%	1799	30%
Deprivation, tertiles[5]						
least level: 8%-14%	2449	51%	2070	28%	2230	38%
moderate level: 15%-16%	245	5%	3285	45%	2059	35%
high level: 17%-43%	2110	44%	1972	27%	1635	27%

[1]Low = "because HIV-symptoms", [2]Moderate = "check-up for diseases other than HIV": 44% other pathologies, 33%, routine health checks, 11% pregnancy or other reproductive health checks, 8% pre-donation testing blood or organs, 4% hospital recovery for non-HIV pathologies; [3]High = "having engaged in behaviour at risk for HIV: 86% unprotected sex, 2% newly HIV diagnosed partner, 12% not specified risk behaviour; [4]we assumed as least educated, individuals living in regions with an education level ranging from 33% to 39% i.e., the "rate" of adults with a lower secondary education level ranging from 33% to 39%, as moderate level from 40% to 41%, and as high level from 42% to 52%; [5]we assumed as least deprived, individuals living in regions with a percentage of families with material deprivation from 8% to 14%, as moderate level from15% to 16%, and high level from 17% to 43%.

Of those classified as with low HIV-risk perception the majority were aged greater than 40 yrs, males, heterosexuals, living in central Italy and living in most educated regions and least deprived regions. Of those classified as aware of HIV-risk perception, the majority were aged less than 40 yrs, MSM, living in the Southern Italy and living in region with moderate level of education.

In particular, of those categorized as with moderate perception, 44% were tested during ascertainments re-

lated to non-HIV symptoms, 33% during routine health checks, 11% for checks during pregnancy or related to medically assisted reproduction, 8% pre-donation testing of blood, or of organs; 4% during hospital recovery for pathologies other than HIV. Of those categorized in the third group and for whom the reason for testing was awareness of behaviours at risk of HIV: 86% because of unprotected sex, 2% because newly HIV diagnosed partner, 12% with a risk behaviour non specified.

Demographic characteristics and socio-economic indicators as determinants of HIV-risk perception at first HIV diagnosis

In *Table 3* both crude Odds Ratios (OR) and adjusted OR (AOR) of demographic and socio-economic characteristics possibly associated with poorer HIV-risk perception *vs* higher levels of HIV-risk perception are shown. In the univariate analysis all variables resulted associated with poorer HIV-risk perception (*Table 3*, crude OR), except for gender with males less likely with low perception [crude OR of males *vs* females: crude OR = 0.91 (95% CI: 0.85-0.97)], for geographical area (those who lived in the North were less likely to be with low perception respect those who lived in the South: crude OR = 0.72, 95% CI: 0.67-0.77); calendar year of diagnosis was not associated with poorer HIV risk perception. Again, when adjusting for all provinces within region of residence as random effect [*Table 3*, AOR, column (a)], results were similar except for gender [AOR of males *vs* females = 0.97 (95% CI: 0.91-1.03)] and for nationality [AOR of Italians *vs* non Italians = 1.03 (95% CI: 0.97-2.00)].

In the full model, regional deprivation (both least and most deprived *vs* moderated deprived) and regional education (least educated *vs* moderate educated), older age (> 40 *vs* ≥ 40 yrs), gender (males *vs* females), HIV-risk group and living in Central Italy resulted all associated with poorer HIV-risk perception (multivariate analysis with all variables: *Table 3*, AOR of column e). Of note, when adding regional deprivation in the model we observed an effect modification for geographical area of residence in the multivariate analysis (*Table 3*, AOR of column d), suggesting that regional deprivation may have a different effect on those living in the North respect to the South of Italy.

The between provinces within region of residence variance (i.e., random intercept) resulted in all models with a p-value < 0.001, indicating that there were significant differences between provinces within region of residence, also after accounting for sociodemographic variables (*Table 3*, see the row with random effects parameters).

DISCUSSION

In Italy we found that there is a fairly high proportion of people HIV diagnosed with poor risk perception at diagnosis, given the reason for undergoing HIV-testing was HIV-symptoms (27%) or non-HIV health checks (40%).

Independent risk factors associated with poorer HIV-risk perception were: regional deprivation (both most and least deprived *vs* moderate deprived areas); living in Central Italy (Centre *vs* South); regional education (least educated *vs* moderate educated areas); HIV-exposure group (heterosexuals and IDU *vs* MSM); older age; gender (males *vs* females). Our results were not directly comparable with other studies, because of different methods/definitions of HIV-risk perception or studied population.

However our findings can be compared with the studies relative to late presentation for HIV care, since late presentation can be considered as a consequence of low risk perception as described by a Swiss HIV Cohort Study, in which late presentation to HIV care was driven by late HIV testing, due to lack of perception about HIV [25]. Furthermore, in our study, this is corroborated by the fact that those defined with lower HIV-risk perception were also, on average, those with the lowest CD4 at diagnosis, as well as those more likely to be with HIV-symptoms at diagnosis, thus those who were more likely to be late presenters as shown in the analyses.

This study found that the effect of regional deprivation on low HIV-risk perception was U-shaped: specifically, we showed that both those most deprived and those least deprived had a significant higher risk of poorer HIV risk perception (58% and 33% increments for those most and least deprived, respectively). In the case of the most deprived regions, our results were similar to the findings of the Swiss study where late presentation for HIV-care has been found to be more frequent in individuals living in neighbourhoods of lower socioeconomic status [25], whereas this is the first study that found an unexpected association of least deprivation with low HIV-risk perception. Meanwhile, in a French study the European Deprivation Index was not associated to late diagnosis [26].

In our opinion this finding (U-shaped effect of deprivation) could reflect the large differences in the organization and provision of HIV care (with possible delay in HIV diagnosis) between the 20 Italian regions. Two realities coexist in Italy [27]: on the one hand the regions with less deprivation (i.e., Northern regions) with consequent better accessibility to diagnostic facilities, therefore with greater probability to be diagnosed also during controls far from the suspicion of HIV (second category of HIV-risk perception definition), from the other, the regions with greater deprivation (especially in the South) and thus, with lower access and consequent greater probability of late diagnosis (first category of poor HIV-risk perception). This remark could partly explain, why when adding the deprivation in the multivariate model we observed a change in the effect of the geographic area. In fact, when we took account of different regional distribution of deprivation thus, lower access in the South and higher access in the North [27], the likelihood of poorer HIV-risk perception was higher in the Northern respect to the Southern area; while instead the differences between Central and Southern Italy persisted.

We observed that regional education affected lower HIV-risk perception for least educated areas *vs* middle educated areas: our result was, partly in contrast with a study performed by a probability sample survey of the British population on HIV risk perception that found

Table 3
Crude Odds Ratio (OR) and adjusted OR of lower HIV-risk perception vs higher HIV-risk perception estimated by ordinal logistic models (n = 18 055 new HIV diagnoses; 107 Italian provinces within 20 regions)

	Univariate models		Adjusted (a)		Adjusted (b)		Adjusted (c)		Adjusted (d)		Adjusted (e)	
	crude OR	p-val	OR	p-val	OR	p-val	OR	p-val	OR	p-val	OR	p-val
Age												
> 40 *vs* ≤ 40 yrs	1.66 (1.58-1.76)	< 0.001	1.71 (1.61-1.81)	< 0.001	1.60 (1.50-1.69)	< 0.001	1.59 (1.50-1.69)	< 0.001	1.60 (1.50-1.69)	< 0.001	1.59 (1.50-1.69)	< 0.001
Gender												
Males *vs* Females	0.91 (0.85-0.97)	0.003	0.97 (0.91-1.03)	0.350	1.30 (1.20-1.40)	< 0.001	1.30 (1.20-1.40)	< 0.001	1.30 (1.20-1.40)	< 0.001	1.30 (1.20-1.40)	< 0.001
HIV-exposure category												
Hetero *vs* MSM	1.88 (1.77-2.00)	< 0.001	1.83 (1.72-1.95)	< 0.001	1.96 (1.82-2.10)	< 0.001	1.96 (1.83-2.10)	< 0.001	1.96 (1.83-2.11)	< 0.001	1.96 (1.83-2.11)	< 0.001
IDU *vs* MSM	1.91 (1.68-2.17)	< 0.001	1.83 (1.60-2.10)	< 0.001	1.82 (1.59-2.08)	< 0.001	1.82 (1.59-2.08)	< 0.001	1.82 (1.59-2.08)	< 0.001	1.82 (1.59-2.08)	< 0.001
Not indicated *vs* MSM	2.02 (1.83-2.23)	< 0.001	2.56 (2.29-2.85)	< 0.001	2.54 (2.27-2.84)	< 0.001	2.55 (2.28-2.85)	< 0.001	2.53 (2.26-2.82)	< 0.001	2.54 (2.27-2.83)	< 0.001
Nationaliy												
Non Italian *vs* Italian	1.10 (1.10-1.04)	0.002	1.03 (0.97-2.00)	0.380	1.06 (0.98-1.13)	0.126	1.05 (0.98-1.13)	0.133	1.06 (0.98-1.13)	0.134	1.06 (0.98-1.13)	0.138
Geographical area												
Center *vs* South	1.80 (1.63-1.98)	< 0.001	1.84 (1.28-2.64)	< 0.001	1.73 (1.20-2.51)	0.003	1.54 (1.11-2.13)	0.007	2.65 (1.84-3.83)	< 0.001	2.11 (1.37-3.24)	< 0.001
North *vs* South	0.72 (0.67-0.77)	< 0.001	0.79 (0.61-1.02)	0.074	0.75 (0.57-0.99)	0.034	0.94 (0.63-1.40)	0.907	1.76 (1.23-2.52)	0.002	1.54 (0.88-2.69)	0.132
Years												
2016 *vs* 2010-2015	1.07 (0.98-1.16)	0.118	1.00 (0.91-1.10)	0.947	1.00 (0.90-1.10)	0.994	1.00 (0.91-1.11)	0.908	0.99 (0.90-1.09)	0.796	1.01 (0.92-1.12)	0.782
Education												
Low *vs* moderate	2.86 (2.66-3.08)	< 0.001	2.87 (2.19-3.76)	< 0.001	_		2.60 (1.93-3.49)	< 0.001	_		1.74 (1.20-2.54)	0.004
High *vs* moderate	1.88 (1.77-2.00)	< 0.001	1.83 (1.43-2.33)	< 0.001	_		1.64 (1.07-2.52)	0.023	_		1.44 (0.93-2.22)	0.104
Deprivation												
Low *vs* moderate	2.19 (2.05-2.34)	< 0.001	2.17 (1.59-2.97)	< 0.001	_		_		1.98 (1.48-2.67)	< 0.001	1.58 (1.14-2.18)	0.006
High *vs* moderate	2.49 (2.33-2.67)	< 0.001	2.60 (1.93-3.50)	< 0.001	_		_		3.86 (2.63-5.67)	< 0.001	2.33 (1.39-3.90)	0.001
Random effects parameters												
variance; SE; p-value	_	_	see note 2		0.369; 0.057; < 0.001		0.247; 0.040; < 0.001		0.242; 0.039; < 0.001		0.221; 0.036; < 0.001	

(a) OR adjusted for provinces within region of residence as random intercept;
(b) OR adjusted for provinces within region of residence as random intercept + individual characteristics;
(c) OR adjusted for provinces within region of residence as random intercept + individual characteristics + education;
(d) OR adjusted for provinces within region of residence as random intercept + individual characteristics + deprivation;
(e) OR adjusted for provinces within region of residence as random intercept + individual characteristics+ education + deprivation
note 2: Random effects parameters (variance; SE; p-val) for model with: age (0.441; 0.066; < 0.001); gender (0.434; 0.066; < 0.001); HIV-exposure cat (0.450; 0.067; < 0.001); nationality (0.435; 0.065; < 0.001); geographical area (0.350; 0.054; < 0.001); years (0.436; 0.066; < 0.001); education (0.266; 0.043; < 0.001); deprivation (0.309; 0.048; < 0.001).

that having academic qualifications was associated with lower HIV risk perception [14] at individual level. Of note, also in our analysis before adjusting for deprivation we observed a similar result, i.e., higher educated areas were associated with lower HIV risk perception, but when adjusting for regional deprivation this effect tended to disappear, suggesting possible interactions between regional education and deprivation.

Our results on demographic risk factors could be overlapped to the same factors reported so far among late presenters in Italy [3] and in rest of Europe [4, 7]. Demographic factors were also consistent with the characteristics of all new HIV diagnoses in Italy [2, 3]: older age, in fact, was associated with HIV-risk percep-

tion, and it reflect the progressive increase of the median age at new HIV diagnosis observed in the IHIVS [3]. Older age was associated with late presentation at diagnosis in Italian studies [3], as well as, in rest of Europe [6, 7], supporting that late presentation in older adults could be a consequence of the higher HIV-risk perception observed in older individuals. Age as risk factor of low HIV-risk perception was also reported by a study conducted in the British population on HIV risk perception and HIV testing: authors showed that low risk perception was associated with being older for all age classes between 25 and 74 yrs independently from educational level [14].

Regarding gender, males showed lower HIV-risk perception than females. This result indirectly confirmed that new Italian HIV diagnoses over time are more frequent among males than females in our surveillance [2, 3], as well as the finding that male gender is generally associated with late presentation in Italian and European studies [3, 4]. However, this result was in contrast with the finding HIV-risk perception was lower among females with respect to males in the general British population [14] and in a Swiss cohort [25].

We found that heterosexual transmission and IDU compared to MSM were associated with lower HIV-risk perception. This finding was similar to that shown by Porter et al., on factors associated with lack of perception of HIV in UK [28] before 1996, and to an Italian cohort study on risk factors relative to late presenters after 1996 [29]. Higher perception of HIV among MSM respect to heterosexual males was shown also in a more recent UK study [14]. However, the finding that MSM showed higher HIV-risk perception respect to IDU and heterosexuals was in contrast with the increasing trend of new diagnoses among MSM reported by Italian HIV surveillance, and the higher proportion of undiagnosed cases estimated among MSM respect the other risk groups in Italy [4]. These findings suggest that although a large part of MSM are aware of HIV at-risk practices, yet a proportion of them engage in high-risk behaviours that feed the reservoir of new undiagnosed infections [30]. These behaviours can be associated with perceived partner knowledge and reasons reflecting perceived gay- and HIV-related stigma, thus delaying HIV testing [31].

This study must acknowledge some limitations. Foremost, any generalization from the results should be made with caution; because of the cross-sectional nature of our data we are not able to draw conclusions about causal effect; further we cannot exclude possible distortion resulting from "ecological fallacy". In fact, the regional education and deprivation level was assigned to new HIV diagnoses according to their area of residence; as a consequence, a patient was defined as "less deprived and/or less educated" because he or she lives in a "less deprived and/or less educated areas". Thus, these results should be confirmed at individual-level, or at least in smaller geographical areas. However, in order to control for this limitation we assigned the regional estimates of education and deprivation to the provinces of residence within regions of each individual residence: in fact Italian provinces are smaller geographic areas respect to the regions (110 Italian provinces *vs* 20 Italian regions), and we obtained similar results when comparing findings from univariate models with those from models adjusted for provinces of residence entered as random effects. Another limit could rely on the definition of HIV-risk perception especially on ordering of the three groups. For instance, why does an opt-out health care check for a pregnant woman would indicate higher risk perception than a doctor's visit due to HIV related symptoms? The only argument as to why this classification ordering was reasonable relies on the fact we observed a lower CD4 count within each group with the decrease of the HIV-risk perception just as it has been defined.

There are a number of strengths in this study. The large study sample included the majority of new HIV-diagnoses performed by HIV surveillance in Italy as shown in a previous study [32] which increases the generalizability of our results. Further, this is the first study on HIV-risk perception using data from a HIV Surveillance System. Another strength is the use of socio-economic indicators that are internationally estimated parameters [20, 21], and this could ensure the reproducibility of these analyses in other European countries.

In conclusion, our findings on risk factors of HIV-risk perception are those reported in the majority of studies for HIV late presenters (i.e., the consequence of low HIV-risk perception): older adults, males, heterosexuals and IDU *vs* MSM, and those living in Central Italy had more likely a low HIV-risk perception at first diagnosis. Further, different regional deprivation and education, seemed to contribute to the lower HIV-risk perception in Italy, indicating that both individual and regional approaches are important in health care policies.

Acknowledgements

The Authors wish to thank all the regional representatives of the HIV Surveillance System for their useful help and constant availability. We would like to thank the colleague Lucia Pugliese of Istituto Superiore di Sanità involved in the management of Italian HIV Surveillance System.

Contributors

All Authors contributed to the design of the study. Dorrucci M and Regine V analysed the data and drafted the manuscript. Pezzotti P and Mammone A contributed with statistical advices; Girardi E contributed to draft data interpretation; Suligoi B coordinates the Italian HIV Surveillance and discussed the results. All Authors commented on drafts of the manuscript and approved the final version.

Funding

Italian HIV Surveillance was supported by the following grants: Ministry of Health – CCM, Article 4, paragraph 7. Enrico Girardi and Alessia Mammone co-Authors were supported by "Ricerca corrente IRCCS INMI L. Spallanzani".

Disclaimer

The funding body had no role in the design, execution, analysis or reporting of the research.

Ethics approval

The study was undertaken in full accordance with the Italian Ministry of Health and Italian National Institute of Health (Istituto Superiore di Sanità) regulations.

Data sharing statement

No additional data available.

Conflict of interest statement

We declare that we have no conflicts of interest.

Received on 19 February 2020.
Accepted on 11 June 2020.

The members of the Italian HIV Surveillance System includes at 31 December 2016:

Manuela Di Giacomo, Viviana Faggioni, Luigi Scancella (Basilicata); Francesco Locuratolo, Gabriella Cauzillo (Abruzzo); Anna Domenica Mignuoli, Daniele Giuseppe Chirico (Calabria); Guglielmo Borgia (Campania); Erika Massimiliani (Emilia Romagna); Tolinda Gallo, Cinzia Braida (Friuli Venezia Giulia); Vincenzo Puro, Paola Scognamiglio, Alessia Mammone (Lazio); Giancarlo Icardi, Piero Luigi Lai (Liguria); Maria Gramegna, Liliana Coppola, Alessandra Piatti, Annamaria Rosa, Danilo Cereda (Lombardia); Fabio Filippetti (Marche); Alessandra Prozzo (Piemonte); Chiara Pasqualini (Molise); Peter Mian, Oswald Moling, Leonardo Pagani (Provincia Autonoma di Bolzano); Paolo Lanzafame, Lucia Collini, Danila Bassetti (Provincia Autonoma di Trento); Maria Chironna (Puglia); Maria Antonietta Palmas (Sardegna); Gabriella Dardanoni (Sicilia); Fabio Voller, Monia Puglia, Lucia Pecori (Toscana); Anna Tosti, Rita Papili (Umbria); Mauro Ruffier, Marina Giulia Verardo, Elisa Francesca Echarlod, Saveria Amoroso (Valle d'Aosta); Francesca Russo, Filippo da Re (Veneto).

REFERENCES

1. Italia. Decreto Ministeriale 31 marzo 2008. Istituzione del sistema di sorveglianza delle nuove diagnosi di infezione da HIV. Gazzetta Ufficiale n. 175. 28 luglio 2008.
2. Camoni L, Boros S, Regine V, Santaquilani M, Ferri M, Pugliese L, e Suligoi B. Aggiornamento delle nuove diagnosi di infezione da HIV dei casi di AIDS in Italia al 31 dicembre 2014. Not Ist Super Sanità. 2015;28(9, Suppl. 1):3-47.
3. Raimondo M, Boros S, Regine V, et al. Aggiornamento delle nuove diagnosi di infezione da HIV dei casi di AIDS in Italia al 31 dicembre 2015. Not Ist Super Sanità. 2016;29(9, Suppl. 1)3-51.
4. Mammone A, Pezzotti P, Regine V, Camoni L, Puro V, Ippolito G, Suligoi B, Girardi E. How many people are living with undiagnosed HIV infection? An estimate for Italy, based on surveillance data. AIDS. 2016;30(7):1131-6. doi:10.1097/QAD.0000000000001034
5. Camoni L, Raimondo M, Regine V, Salfa MC, Suligoi B. Late presenters among persons with a new HIV diagnosis in Italy, 2010–2011. BMC Public Health. 2013;13:281. doi:10.1186/1471-2458-13-281
6. Mocroft A, Lundgren JD, Sabin ML, et al. Risk factors and outcomes for late presentation for HIV-positive persons in Europe: results from the Collaboration of Observational HIV Epidemiological Research Europe Study (COHERE). PLoS Med. 2013;10(9):e1001510. doi:10.1371/journal.pmed.1001510
7. The late presenters working group in COHERE in EuroCoord. Late presentation for HIV care across Europe: update from the Collaboration of Observational HIV Epidemiological Research Europe (COHERE) study, 2010 to 2013. Euro Surveill. 2015;20. doi: http://dx.doi.org/10.2807/1560-7917. ES.2015.20.47.30070
8. Tully S, Cojocaru M, Bauch CT. Sexual behavior, risk perception, and HIV transmission can respond to HIV antiviral drugs and vaccines through multiple pathways. Sci Rep. 2015;28:15411.
9. Corneli AL, McKenna K, Headley J, et al. EM-PrEP Study. A descriptive analysis of perceptions of HIV risk and worry about acquiring HIV among FEM-PrEP participants who seroconverted in Bondo, Kenya, and Pretoria, South Africa. J Int AIDS Soc. 2014;17(3, Suppl. 2):19152. doi: 10.7448/IAS.17.3.19152
10. Dearborn JL, Lewis J, Mino GPPreventing mother-to-child transmissionin Guayaquil, Ecuador: HIV knowledge and risk perception. Glob Public Health. 2010;5(6):649-62. doi: 10.1080/17441690903367141
11. Filipe EM, Batistella E, Pine A, Santos NJ, Paiva V, Segurado A, Hearst N. Sexual orientation, use of drugs and risk perception among HIV-positive men in Sao Paulo, Brazil. Int J STD AIDS. 2005;16:56-60.
12. Koh KC, Yong LS. HIV Risk Perception, Sexual Behavior, and HIV Prevalence among Men-Who-Have-Sex-with-Men at a Community-Based Voluntary Counseling and Testing Center in Kuala Lumpur, Malaysia. Interdiscip Perspect Infect Dis. 2014;236240. doi: 10.1155/2014/236240
13. Evangeli M, Baker LL, Pady K, Jones B, Wroe AL. What leads some people to think they are HIV-positive before knowing their diagnosis? A systematic review of psychological and behavioural correlates of HIV-risk perception AIDS Care. 2016;28:943-53. doi: 10.1080/09540121.2016.1139040
14. Clifton S, Nardone A, Field N, Mercer CH, Tanton C, Macdowall W, Johnson AM, Sonnenberg P. HIV testing, risk perception, and behaviour in the British population. AIDS. 2016;30:943-52. doi: 10.1097/QAD.0000000000001006
15. Evangeli M, Pady K, Abigail LW. Which psychological factors are related to HIV testing? A quantitative systematic review of global studies. AIDS Behav. 2016;20(4):880-918. doi: 10.1007/s10461-015-1246-0
16. MacKellar DA, Valleroy LA, Secura GM, et al. Men survey study. Unrecognized HIV infection, risk behaviors, and perceptions of risk among young men who have sex with men – Opportunities for advancing HIV prevention in the third decade of HIV/AIDS. Jaids. 2005;38;603-14. doi: 0.1097/01.qai.0000141481.48348.7e
17. Massari V, Lapostolle A, Grupposo MC, Dray-Spira R, Costagliola D, Chauvin P. Which adults in the Paris metropolitan area have never been tested for HIV? A 2010 multilevel, cross-sectional, population-based study. BMC Infect Dis. 2015;15:278. doi: 10.1186/s12879-015-1006-9

18. ISTAT. Indicatori territoriali per le politiche di sviluppo. ISTAT; 2020. Available from: www.istat.it/it/condizioni-economiche-famiglie.http://www.istat.it/it/archivio/16777
19. European Commission. Eurostat Statistical Books; 2014. Living conditions in Europe. 2014. Available from http://ec.europa.eu/eurostat/.
20. European Commission. Eurostat Statistical Books; 2015. Quality of life, fact and views. 2015. Available from: http://ec.europa.eu/eurostat/.
21. O'Connell AA. Logistic regression models for ordinal response variables. Thousand Oaks, CA: Sage Publications; 2006.
22. Goldstein H. Multilevel statistical models, 4nd ed. Chichester, UK: John Wiley and Sons; 2011.
23. Moerbeek M. The consequences of ignoring a level of nesting in multilevel analysis. Multivariate Behavioral Research. 2004;39:129-49. doi:10.1207/s15327906mbr3901_5
24. Hachfeld A, Ledergerber B, Darling K, Weber R, Calmy A, Battegay M, Sugimoto K, Di Benedetto C, Fux CA, Tarr PE, Kouyos R, Furrer H, Wandeler G; Swiss HIV Cohort Study. Reasons for late presentation to HIV care in Switzerland. J Int AIDS Soc. 2015;18:20317. doi: 10.7448/IAS.18.1.20317
25. Cuzin L, Yazdanpanah Y, Huleux T, Cotte L, Pugliese P, Allavena C, Reynes J, Poizot-Martin I, Bani-Sadr F, Delpierre C; Dat'AIDS Study Group. No relationship between late HIV diagnosis and social deprivation in newly diagnosed patients in France. HIV Med. 2018;19(3):238-42. doi: 10.1111/hiv.12545
26. Fantini MP, Lenzi J, Franchino G, et al. Mortality amenable to health care services and health inequalities among Italian Regions. Epidemiol Prev. 2014;38:100-7.
27. Porter K, Wall PG, Evans BG. Factors associated with lack of awareness of HIV infection before diagnosis of AIDS. BMJ. 1993;307:20-3
28. Raffetti E, Postorino MC, Castelli F, et al. The risk of late or advanced presentation of HIV infected patients is still high, associated factors evolve but impact on overall mortality is vanishing over calendar years: results from the Italian MASTER Cohort. BMC Public Health. 2016;16:878. doi: 10.1186/s12889-016-3477-z
29. Gios L, Mirandola M, Toskin I, et al. Bio-behavioural HIV and STI surveillance among men who have sex with men in Europe: the Sialon II protocols. BMC Public Health. 2016;16:212. doi: 10.1186/s12889-016-2783-9
30. Marcus U, Gassowski M, Drewes J. HIV risk perception and testing behaviours among men having sex with men (MSM) reporting potential transmission risks in the previous 12 months from a large online sample of MSM living in Germany. BMC Public Health. 2016;16:1111.
31. Camoni L, Regine V, Stanecki K, Salfa MC, Raimondo M, Suligoi B. Estimates of the Number of People Living with HIV in Italy. Biomed Res Int. 2014;2014:209619. doi: 10.1155/2014/209619