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Abstract

Aims. Information on high risk drug use in Turkey particularly at the regional level is lacking. The present analysis aims at estimating high risk cannabis (HRCU) and high risk opiate use (HROU) in the cities of Ankara, Istanbul and Izmir. **Design and Methods**. Capture-recapture (CRC) and multiplier methods (MM) were applied based on treatment and police data stratified by age and gender in the years 2009 and 2010. Case definitions refer to ICD-10 cannabis (F.12) and opiate (F.11) disorder diagnoses from out- and inpatient treatment records and illegal possession of these drugs as recorded by the police. **Results**. HRCU was estimated at 28,500 (8.5 per 1,000; 95%-CI: 7.3-10.3) and 33,400 (11.9 per 1,000; 95%-CI: 10.7-13.5) in Ankara and Izmir, respectively. Using multipliers based on CRC estimates for Izmir, HRCU in Istanbul was estimated up to 166,000 (18.0 per 1,000; range: 2.8-18.0). CRC estimates of HROU resulted in 4,800 (1.4 per 1,000; 95% CI: 0.9-1.9) in Ankara and multipliers based on these gave estimates up to 20,000 (2.2 per 1,000; range: 0.9-1-7) in Istanbul. HROU in Izmir was not estimated due to the low absolute numbers of opiate users. **Discussion and Conclusions**. While HRCU prevalence in both Ankara and Izmir was considerably lower in comparison to an estimate for Berlin, the rate for Istanbul was only slightly lower. Compared to the majority of European cities HROU in these three Turkish cities may be considered rather low.

Introduction

It is important to epidemiologists to be able to track the numbers of substance users in an area, and it is essential to health and social service providers to know the numbers of problem drug users (PDU) for whom services will in the first place be required. Consequently, the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) has established as one of its five Key Indicators, the estimation of the numbers of high-risk drug users (HRDU, a recent redefinition and renaming of the former PDU Key Indicator). Member States are expected to provide annual estimates of the numbers of persons involved in high-risk drug use, meaning "recurrent drug use that is causing actual harms (negative consequences) to the person (including dependence, but also other health, psychological or social problems) or is placing the person at a high probability/risk of suffering such harms" [1].

As implemented in most countries, the HRDU indicator has tended to focus on marginalized heavy users of opiates. The EMCDDA has produced a series of guidelines describing estimation methods. These include direct methods of counting through surveys, which *may be* practicable for cannabis but are generally held to be unsuitable for substances such as opiates, the marginalized users of which may tend to be unreachable in conventional surveys and unwilling to admit to their illegal activity. Indirect methods may be required for the hard-to-reach populations. These include multiplier methods and capture-recapture estimation from incomplete but overlapping lists; these methods are widely used in EU countries and affiliated states. The study reported in the present paper was carried out in order to apply for the first time methods of this kind to estimating numbers of drug users in Turkey, within the context of moving towards the harmonisation of information in Turkey with the European Union.

Previous epidemiological studies investigating substance use in Turkey have been limited primarily to self-reports in school and university-based surveys. Compared to EU countries, the available data in Turkey suggest rather low prevalence rates for any drug use, including cannabis [2] which appears to be the most widely used substance among school and university students. The rates that have been reported vary depending on the setting, study population and year of the survey. Lifetime prevalence rates of self-reported drug use among university students range between 2.3 and 6.6% [3-7]. Naturally, lower rates of any lifetime use were recorded among primary and secondary school students [8-10]. Beyond these studies that have been conducted at the regional or city level among school or university students there are very few referring to the general population [11;12].

Estimates of drug use and drug use patterns derived from school, college or population studies rely on self-reports. However, as in every country, drug laws and prosecution of possession may result in drug users hiding this particular behaviour and not admitting it even if anonymity is assured. Depending on the degree of stigmatization and social exclusion of drug users, surveys are likely to miss this subgroup. Thus, the lack of reliable data on drug use and particularly on opiate use in the general population calls for the application of indirect methods of estimating the drug using population. The capture-recapture method (for an overview see [13]) employs information from various sources where drug users are registered, such as treatment services, police or the criminal justice system (convictions or probation). Registers are usually available at regional or community level. It is necessary to be able to identify individuals, in order to determine whether the same person appears in more than one register. Alternatives to capture-recapture analysis include Multiplier Methods [14]. The drug using population is derived by estimating what proportion of the population is hidden and applying this figure to the number of observed users. The present study set out to estimate the

numbers of high risk opiate and cannabis users in the three largest Turkish cities of Ankara, Istanbul and Izmir.

Methods

Data sources

Drug-related data was requested for in- and out-patient treatment as well as for police arrests consisting of personal ID code, demographic information such as age, gender and region, type of drug use, and, for the treatment data, diagnosis of substance use disorders. Data was collected according to the area where the person obtained addiction treatment or was arrested, and was recorded at the level of provinces rather than cities. However, as the three cities are overwhelmingly the main population centers of their respective provinces, we will hereafter refer to cities rather than provinces. For reasons of data protection, personal information of each individual in each source was coded. The identifiers were used to determine the overlap between sources and were deleted once the overlap pattern had been established. The code used for each individual in each of the sources was forename initial, surname initial, date of birth and gender. For both sources information was available for the years 2009 and 2010.

Case Definition

Records on inpatient and outpatient treatment were based on ICD-10 codes indicating diagnoses of substance use disorders (F10-F19). Police records contained labels of the drug involved in the person's arrest for drug possession. The pattern of drug use captured by the combination of cannabis- or opiate-related disorders and an indicator of illegal possession of cannabis or opiates was labelled "high risk cannabis use" (HRCU) and "high risk opiate use" (HROU). In this context, high risk use defines a drug-using behaviour that may eventually lead to health or judicial high risks.

Statistical Analysis

Data were analysed using the capture-recapture method (CRC) [15]. For all analyses, data were stratified by age group (15-24, 25-34, and 35-64 years) and gender, and log-linear Poisson regression models were fitted separately to the stratified pattern of overlaps between the sources of data. It is not recommended to use CRC with only two sources, because it is then necessary to assume independence of the two sources [16]; this is an untestable and usually improbable assumption. For this reason, four-source analyses were carried out, treating each year's data from treatment and police as a separate source. Other studies have also increased the effective number of sources by using the same source in different periods of time [17-19]. For each stratified analysis the simplest 22 models were fitted; these models had up to two two-way interactions between data sources. The deviance statistic, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) were used to assess how well each model fitted the data [20]. If none of these models provided a good fit, age categories were collapsed and analyses were repeated; in the event, this was done for all the analyses of females. The best fitting model was used to estimate the size of the "hidden population" of drug users who had not been recorded by any data source. Confidence intervals around these estimates were constructed by the profile likelihood method [21]. Confidence intervals for the totals of separate estimates across age groups and gender were derived by a simulation-based method [22].

For estimating the number of high risk cannabis as well as high risk opiate users in Istanbul, none of the models resulted in satisfactory model fit. Instead, the ratio of the number of estimated users to the number of "captured" users in Izmir (for cannabis) and Ankara (for opiates) was used as multiplier on each of the four sources [14;23]. The reason for choosing

Izmir instead of Ankara as an anchor for the Multiplier Method (MM) was based on Turkish experts' view on drug use in the three cities. Izmir and Istanbul are both quite 'western' in outlook and it was felt appropriate to assume that a cannabis multiplier for Izmir would be valid for Istanbul. Conversely, opiate use was observed an issue in Ankara and Istanbul, but not in Izmir. Inspection of the raw data confirmed these subjective observations. Due to the low absolute numbers of opiate users "captured" in Izmir (Table 1), we refrained from estimating HROU. For calculating population rates for HRCU and HROU users per 1,000 population, data on the numbers of 15–64 year-olds by age group and gender were obtained for each province for the years 2009 and 2010 from the Turkish population registry. The averages of the two years were taken.

Table 1

Results

Estimates of the number of high risk cannabis users

For Ankara, the Poisson log-linear model that included the interaction between the two years of treatment data provided an adequate fit to the data in the analysis of cannabis use in each age group for males and in an analysis for all females. Table 2 presents the key results. The estimated number of male users was 26,428 and of females 2,064, resulting in a male to female ratio of 13:1. The rates per 1,000 population aged 15 to 64 years were 15.8 (95% CI: 13.5-19.3) among males, 1.2 (95% CI: 0.7-2.6) among females and 8.5 (95% CI: 7.3-10.3) overall.

Table 2

The same model provided an adequate fit to the data on males in Izmir, in every age group, and to all females (Table 2). The number of male users was estimated at 30,140 and of females at 3,244, resulting in a male to female ratio of 9:1. Rates per 1,000 population were 21.3 (95% CI: 19.2-23.6) for males, 2.3 (95% CI: 1.3-5.0) for females and 11.9 (95% CI: 10.7-13.5) overall.

For Istanbul, the model including the interaction between the two years of treatment data fitted only the data for males aged 35-64 years. The interaction between the two years of police data had to be added in order to obtain statistically acceptable fit in the other two age groups. However, the resulting estimates of hidden populations for both genders yielded implausible estimates with excessively wide confidence intervals. Instead, the multiplier approach based on the estimates for Izmir was applied yielding a total ranging between 160,373 and 166,045 high risk cannabis users for the two treatment sources and between 26,078 and 34,456 high risk cannabis users for the two police sources. Rates per 1,000 population aged 15 to 64 years ranged between 2.8 and 18.0 depending on data source (range for males: 5.1-32.3; range for females: 0.5-3.4; data for genders not shown) (Table 3).

Table 3

Estimates of the number of high risk opiate users

The results of the capture-recapture estimation of high-risk opiate use in Ankara are shown in Table 2. Only 121 female opiate users were observed, while seven times as many male users were identified in the four sources. In all male age groups the interaction between the two treatment years yielded the best model fit. In the combined female sample, it was necessary to use the interaction between treatment in 2009 and police in 2010. A total of 4,760 (1.4 per

1,000; 95% CI: 0.9-1.9) opiate users was estimated for Ankara, with 4,117 (2.5 per 1,000; 95% CI: 2.1-3.2) male and 643 (0.4 per 1,000; 95% CI: 0.2-0.8) female users.

Based on the estimates for HROU in Ankara, multipliers for each of the four data sources were constructed and applied as multipliers to the Istanbul data (Table 3). The estimates ranged between 8,204 and 20,114 high risk opiate users in total, depending on data source (rates per 1,000: 0.9.-2.2). The estimates for males ranged from 7,711 (1.7 per 1,000) to 19,600 (4.2 per 1,000) and for females from 493 (0.1 per 1,000) to 2,053 (0.4 per 1,000) (data for genders not shown).

Discussion

To the best of our knowledge, this is the first study estimating the number of high risk cannabis and opiate users in major Turkish cities, namely Ankara, Istanbul and Izmir, using capture-recapture and multiplier methods. While the main focus of the study was on estimating substance use related disorders according to the ICD-10 definition, only the treatment data met this condition. Given the less rigorous definitions of high risk behaviour found in police records, we need to acknowledge that our estimates may also encompass drug users who do not fulfil the ICD-10 criteria of harmful use or dependence. However, expert opinion supports the view that subjects registered by the police because of drug use may be considered high risk drug users.

The capture-recapture method yielded higher rates of high risk cannabis users per 1,000 population in Izmir (11.9; 95% CI: 10.7-13.5) than in Ankara (8.5, 95% CI: 7.3-10.2). Using the CRC results for Izmir as anchor for estimating HRCU in Istanbul resulted in a wide range with a minimum mean of 2.8 and a maximum mean of 18.0 per 1,000. Applying the lower

and upper limits of the 95% CI of the CRC point estimate the range widened to 2.3-23.4 cases per 1,000. The multiplier method provided estimates for each of the four sources separately. Rates derived from police data (2.8-3.7 per 1,000) were much lower than those from treatment data (17.4-18.0 per 1,000). This is due to substantial differences between the numbers of individuals known to the police in Izmir and Istanbul and between individuals presenting for treatment in both cities. In fact, in the two younger age groups the number of cases known to the police in Istanbul was only slightly higher than in Izmir, while in the older age group and in females the absolute number of cases known to the police in Istanbul was even lower than in Izmir. Conversely, the number of people presenting for treatment was between three to five times higher in Istanbul than in Izmir. Given a 3.5 times larger population in Istanbul than Izmir, a much higher number of arrests for cannabis possession would have been expected in Istanbul. Apart from the unexpectedly low numbers of police arrests that clearly underestimates the true prevalence when used in the multiplier method, there was almost no overlap observable between individuals identified by police and treatment services in the two consecutive years, which led to implausible CRC estimates.

Unfortunately, comparable data on high risk cannabis users are available neither in Turkey nor in member states of the European Union. While the EMCDDA collects prevalence and treatment data, estimates of HRCU using standardized methods are missing [24]. However, the estimates of HRCU for Ankara, Istanbul and Izmir may be compared with the results of the most recent study conducted in Berlin in 2012 using DSM-IV diagnoses for cannabis use disorders [25]. Based on survey data the estimated mean rate of 25 HRC users per 1,000 population for Berlin was more than twice as high as the estimate for Izmir (11.9) and three times as high as the estimate for Ankara (8.5). Compared to the estimate for the German

capital, the mean rate of HRCU for Istanbul based on treatment data (18.0) was only slightly lower.

The prevalence of high risk opiate users based on CRC was estimated at 1.4 per 1,000 (95% CI: 0.9-1.9) in Ankara and using Ankara as anchor for the multiplier method at between 0.9 and 2.2 in Istanbul. Compared to the overall Turkish estimate of 0.26 per 1,000 inhabitants aged 15-64 years in the year 2011, the figures for Ankara and Istanbul derived from the present analysis were higher. Rates of high risk opiate users can also be compared to national estimates reported by the European Monitoring Centre for Drugs and Drug Addiction [26]. According to the EMCDDA, estimates of HROU at the city level vary from 2.3 in Budapest (in 2005) to 19.8 in Manchester (in 2006) [27]. Compared with these figures and the results from the most recent CRC study in Berlin with estimates ranging between 4.7 and 7.0 per 1,000 population for the year 2010 [28], the estimates for the two Turkish cities may still be considered low.

In order to justify the validity of the results, the assumptions that must be met in applying capture-recapture methods must be considered. (1) The "closed population" assumption may be violated if drug users begin or stop using drugs, or if they move into or out of the area that is being studied within that time period. The issue of starting and stopping drug use is usually dealt with by restricting the time period of the study. However, in the present case it was necessary to use two years, a longer period than usual, in order to have an adequate number of data sources. (2) Matching individuals through the anonymous identifiers may not have been free of mistakes. Cross-referencing with a reduced set of identifiers can lead to false matching and impact on the validity of the prevalence estimates. In each data source we found about 5% of persons born on January 1st which, in Turkey, is the registration date used for individuals

with unknown day and month of birth. A slightly overrepresentation of these cases may have led to more overlaps due to false positive matches. (3) The "heterogeneity" assumption addresses the possibility of different probabilities for individuals of appearing in a particular source, for example, young drug users may be less likely than older drug users to have started treatment and therefore appear in a treatment data source. This risk was reduced by stratifying samples according to age and gender. Nevertheless, recent research has examined the impact of possible breaches of the traditional capture-recapture assumptions, such as heterogeneity of capture and independence of data sources [29;30]. As all of these mechanisms may simultaneously impact on the overlap patterns of the data used for CRC, it can be said that influences lowering the overlap will generally result in overestimating the true prevalence, whereas increasing the overlap will result in underestimating the true prevalence. Statistics on drug-related deaths, although very likely subject to underreporting, suggest low numbers of opiate-related deaths in the three cities, which supports the findings of a low prevalence of high risk opiate users in Turkey [31].

Due to the wide range of the presented estimates the multiplier method may be regarded as inaccurate and less reliable than CRC. Nevertheless, when using Ankara instead of Izmir as anchor for estimating HRCU in Istanbul, results turned out to be rather similar except for a narrower range of estimates (data available on request). We also note that changes in the numbers in treatment between 2009 and 2010 could indicate that the proportions in treatment vary across time, perhaps due to treatment being more accessible in the later year. This may have an impact on the assumption that a common multiplier can be used across different time periods and also across different geographical areas. Table 3 does, however, suggest that a treatment multiplier produces consistent estimates across years in Istanbul. For estimating high risk drug use in other Turkish cities alternative indirect methods such as synthetic

estimation could have been used [32]. Unfortunately, the three cities are too few and not suitable for a geographical representation of urban areas in Turkey. Respondent driven sampling (RDS) [33] has been found efficient and effective for investigating drug-using populations. Recent developments [34] provide a method for estimating population size and hence drug use prevalence from RDS data, although this is still relatively untested. However, in contrast to our use of existing administrative data for CRC estimation, RDS requires special studies, which are unlikely to be feasible on a large scale.

The main limitations of the study refer to the reliability and validity of the register data, which were not collected for the present purpose of estimating the number of high risk drug users. Addiction treatment in Turkey is usually provided in specialized centres established in large governmental mental hospitals. In most cases inpatient treatment is limited to only detoxification. In some of these treatment centres a 4-week program including group therapies and recreational groups is provided in addition to medical management. Due to lack of addiction treatment professionals, outpatient treatment available in governmental hospitals is limited to only medical management. There are a few small private hospitals that provide addiction treatment, but long term rehabilitation or residential treatment is not available [31]. Also the wide variation in the number of drug users arrested by the police over the years and across cities raises questions regarding the validity of the data. It is unclear whether this variation resulted from differences in police activities, changes over time, or errors in or lack of reporting, or whether it reflects differences in drug using behaviour. More research is needed to understand the data collection mechanisms.

Nonetheless, despite these limitations, the present analysis yielded for the first time estimates of the scale of high risk drug cannabis and opiate use in three major Turkish cities using

capture-recapture and multiplier methods. It demonstrates the feasibility of these approaches and calls for further activities in the monitoring of drug use. Future studies will be necessary to validate these initial estimates.

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Declaration of interest

The authors have no conflict of interest.

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Table 1: Number of individuals recorded in each data source by year of registration, drug used, age and gender.

Ankara	Year	Cannabis				Opiates			
		Males			Females	Males			Females
		15-24	25-34	35-64	15-64	15-24	25-34	35-64	15-64
Treatment	2009	60	33	20	24	42	34	34	26
Treatment	2010	165	87	29	41	229	94	47	55
Police	2009	478	631	271	86	98	61	24	25
Police	2010	695	673	290	78	277	136	52	30
Istanbul		**15-24**	**25-34**	**35-64**	**15-64**	**15-24**	**25-34**	**35-64**	**15-64**
Treatment	2009	175	177	81	100	98	150	138	83
Treatment	2010	316	221	110	96	282	255	182	157
Police	2009	1,258	1,292	403	66	81	216	353	20
Police	2010	891	976	393	82	121	210	279	23
Izmir		**15-24**	**25-34**	**35-64**	**15-64**	**15-24**	**25-34**	**35-64**	**15-64**
Treatment	2009	51	28	14	21	3	5	5	7
Treatment	2010	97	29	26	33	14	12	12	19
Police	2009	1,023	1,086	587	126	0	2	7	0
Police	2010	1,189	1,073	574	117	4	20	11	0

Table 2: Capture-recapture estimates of the number of high-risk cannabis users in Ankara and Izmir, and estimates of the number of high-risk opiate users in Ankara.

Ankara (Cannabis) [1)]	Deviance (df [3)])	Observed cases	Estimated hidden population	Total	95% confidence interval	Rate per1,000 [4)]
Males 15-24	14.1 (9)	1,325	8,094	9,419	7,545 – 11,944	23.6 (18.9-29.9)
Males 25-34	8.2 (9)	1,362	9,123	10,485	8,279 – 13,641	24.4 (19.3-31.8)
Males 35-64	6.7 (9)	592	5,932	6,524	4,257 – 10,919	7.7 (5.0-12.9)
All males		3,279	23,149	26,428	22,495 – 32,194	15.8 (13.5-19.3)
Females	10.5 (9)	217	1,847	2,064	1,159 – 4,397	1.2 (0.7-2.6)
Total		**3,496**	**24,996**	**28,492**	**24,495 - 34,421**	**8.5 (7.3-10.3)**
Izmir (Cannabis) [1)]						
Males 15-24	19.1 (9)	2,230	10,260	12,490	10,693 – 14,773	38.0 (32.6-45.0)
Males 25-34	11.6 (9)	2,089	8,405	10,494	9,009 – 12,382	30.2 (25.9-35.6)
Males 35-64	3.9 (9)	1,146	6,010	7,156	5,670 – 9,291	9.7 (7.7-12.6)
All males		5,465	24,675	30,140	27,162 – 33,451	21.3 (19.2-23.6)
Females	9.3 (9)	282	2,962	3,244	1,807 – 6,941	2.3 (1.3-5.0)
Total		**5,747**	**27,537**	**33,384**	**29,813 – 37,637**	**11.9 (10.7-13.5)**
Ankara (Opiates) [2)]						
Males 15-24	9.3 (9)	574	1,468	2,042	1,660-2,557	5.1 (4.2-6.4)
Males 25-34	9.0 (9)	287	842	1,129	830-1,592	2.6 (1.9-3.7)
Males 35-64	11.8 (9)	141	805	946	501-1,944	1.1 (0.6-2.3)
All males		1,002	2,115	4,117	3,428-5,430	2.5 (2.1-3.2)
Females	12.9 (9)	121	522	643	357-1,398	0.4 (0.2-0.8)
Total		**1,123**	**3,637**	**4,760**	**2,973-6,188**	**1.4 (0.9-1.9)**

1) Poisson log-linear models including interaction between treatment in 2009 and 2010
2) Poisson log-linear models including interaction between treatment in 2009 and 2010 for males, and interaction between treatment in 2009 and police in 2010 for females
3) Degrees of freedom
4) Rate per 1,000 population in the relevant age group (15-64 years for totals)

Table 3: Multiplier estimates for high risk cannabis users in Istanbul based on capture-recapture estimates for Izmir, and estimates for high risk opiate users in Istanbul based on capture-recapture estimates for Ankara.

Source	Estimated number of high-risk cannabis users (multiplier CRC Izmir)				Total	Rate per 1,000*	Estimated number of high-risk opiate users (multiplier CRC Ankara)				Total	Rate per 1,000*
	M			F		Mean (lower-upper)	M			F		Mean (lower-upper)
	15-24	25-34	35-64	15-64			15-24	25-34	35-64	15-64		
Treatment 2009	42,858	66,337	41,403	15,448	166,045	18.0 (14.6-23.4)	4,765	4,981	3,840	2,053	15,638	1.7 (1.2-2.7)
Treatment 2010	40,689	79,972	30,275	9,437	160,373	17.4 (14.4-21.9)	2,515	3,063	3,663	1,835	11,076	1.2 (0.8-2.1)
Police 2009	15,359	12,485	4,913	1,699	34,456	3.7 (3.1-4.7)	1,688	3,998	13,914	514	20,114	2.2 (1.3-4.1)
Police 2010	9,360	9,545	4,899	2,274	26,078	2.8 (2.3-3.6)	892	1,743	5,076	493	8,204	0.9 (0.5-1.6)

* rate per 1,000 population in the age group 15-64 years