Increasing potency and price of cannabis in Europe, 2006-2016

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Abstract

Aims: To quantify changes in (i) potency (concentration of Δ^9-tetrahydrocannabinol; %THC), (ii) price (Euros/gram of cannabis), and (iii) value (quantity of THC per price unit; mg THC/Euro) of cannabis resin and herbal cannabis in Europe.

Design: Repeated cross-sectional study.

Setting and participants: Data collected from 28 EU member states, Norway and Turkey by the European Monitoring Centre for Drugs and Drug Addiction.

Measurements: Outcome variables were potency, price, and value for cannabis resin and herbal cannabis in Europe, 2006-2016. Inflation was estimated using the Harmonised Indices of Consumer Prices. Mixed effects linear regression models were used to estimate linear and quadratic time trends, with a random intercept and slope fitted to account for variation across countries.

Findings: Resin potency increased from a mean (95% CI) of 8.14% THC (6.89, 9.49) in 2006 to 17.22 (15.23, 19.25) in 2016. Resin price increased from 8.21 Euros/gram (7.54, 8.97) to 12.27 (10.62, 14.16). Resin increased in value, from 11.00 mg THC per Euro (8.60, 13.62) to 16.39 (13.68, 19.05). Quadratic time trends for resin potency and value indicated minimal change from 2006-2011, followed by marked increases from 2011-2016. Herbal cannabis potency increased from 5.00% THC (3.91, 6.23) to 10.22 (9.01, 11.47). Herbal price increased from 7.36 Euros/gram (6.22, 8.53) to 12.22 (10.59, 14.03). The value of herbal cannabis did not change from 12.65 mg of THC (10.18, 15.34) to 12.72 (10.73, 14.73). All price trends persisted after adjusting for inflation.

Conclusions: European cannabis resin and herbal cannabis increased in potency and price from 2006-2016. Cannabis resin (but not herbal cannabis) increased in the quantity of Δ^9-tetrahydrocannabinol per Euro spent. Marked increases in resin potency and value from 2011-2016 are consistent with the emergence of new resin production techniques in European and neighbouring drug markets.

Key words: Cannabis, THC, potency, price, herbal, resin, drug markets.

Introduction

Cannabis is used by an estimated 192 million people each year worldwide in a variety of drug markets, ranging from heavily sanctioned prohibition to commercialised legal sale (1). A key component of cannabis markets is drug potency - typically quantified as the concentration of Δ^9-tetrahydrocannabinol (THC) in cannabis products. Several lines of evidence suggest that products with higher THC concentrations carry a greater risk of harm. Firstly, several (2-6) (but not all (7)) observational studies have found associations between the potency of cannabis products and problems related to addiction and mental health. Secondly, naturalistic studies indicate that cannabis users only partially adapt their smoking behaviour to variation in potency, resulting in higher doses of THC when using more potent products (8, 9). Thirdly, experimental studies show dose-dependent effects of THC on cognitive impairment, anxiety, psychotic-like symptoms, and addiction, with higher doses causing greater harm (10). There are only a limited number of published studies to date investigating the potency of cannabis products in international drug markets. Quantifying cannabis potency is therefore a key step towards improving our understanding of the health effects of cannabis (11) and may inform policy decisions for harm minimisation, such as taxation or upper limits on THC concentrations (12, 13).

An important feature of European cannabis markets is the presence of resin (also referred to as hashish or hash); compressed blocks of extracted plant matter that are typically brown in colour. Arguably, the most important changes in European cannabis products in recent years have occurred in cannabis resin. Resin is primarily imported to Europe from Morocco; however it is also imported from Lebanon and Afghanistan and produced domestically within Europe

(14). Resin found in European markets has been reported to contain significant levels of cannabidiol (CBD), a non-intoxicating cannabinoid that may offset THC harms (15-17) and is typically absent from herbal cannabis. Traditional resin production methods often include a mixture of three plant chemotypes (THC-dominant, CBD-dominant, THC and CBD) found in landrace crops (18) such as Moroccan "kif". As THC and CBD are synthesised from a common precursor, the mixture of chemotypes used in traditional resin production methods can result in modest levels of THC, with balanced (roughly equal) levels of CBD. By contrast, THC-dominant plants can produce higher levels of THC with little or no CBD (19) and are often used to cultivate herbal cannabis, higher potency forms of resin, and concentrated extracts (20).

Recent data suggest that Moroccan resin production has shifted away from traditional landrace "kif" crops to THC-dominant strains, resulting in marked increases in THC concentrations (21, 22). The effects of these changes are evident in the French cannabis market, as documented by a 25-year study of police seizures (23). The authors reported a substantial increase in resin potency starting in 2011, driven by the emergence of a new type of resin exceeding 20% THC. Increases in THC concentrations were also detected in resin samples collected from police seizures in the UK from 2004-5 (18) to 2015-6 (24) and in Italy from 2010-2013 (25, 26). By contrast, THC concentrations in imported resin samples purchased from coffee shops in the Netherlands were largely stable in potency from 2005-2015 (27). However, the extent to which new higher potency resin samples have penetrated cannabis markets at the European level is currently unknown.

Regarding herbal cannabis in Europe, a small number of country-specific studies have reported changes in potency. In the Netherlands, domestic herbal cannabis showed a marked increase in THC from 2000-2004 (28) followed by marginal decrease from 2005-2015 (27). In the UK,

the potency of herbal cannabis was broadly similar in 2004-5 (18) compared to 2015-6 (24), but increased each year from 2010-2013 (25, 26) in Italy and from 1995-2016 in France (23). A meta-analysis of herbal cannabis potency worldwide reported annual increases (mean of 0.21% THC per year) from 1970-2009 (29). However, the extent to which European herbal cannabis potency has changed in recent years is currently unclear.

Price is another key aspect of cannabis markets, and has been found to be positively correlated with potency, both in illicit markets (28, 30) and legal markets (31, 32). Data collected since the advent of legal sales in Washington State indicate that the retail price of cannabis has continued to fall over time (31, 32). As changes in both potency and price may influence purchasing behaviour and consumption (33-35), combined measures may be informative. One such as measure the quantity of THC that can be purchased with a fixed unit of price (e.g. one Euro). This offers a measure of value that can be compared across time or different cannabis products. However, information on the price of cannabis products in Europe is extremely limited at present.

At the time of writing, legal markets for recreational cannabis are yet to emerge in Europe, but global cannabis policy is rapidly shifting towards legalisation of recreational and medical cannabis. It is therefore timely to provide European estimates of the potency and price of cannabis products, to contribute to the available knowledge on international cannabis markets and how they respond to policy changes. Data on cannabis potency and price are collected by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) on an annual basis from the 28 EU member states, Norway and Turkey. The objective of these tools is to collect accurate, reliable, comparable and high-quality data on European drug markets. Using these

data, we aimed to quantify for the first time changes in (i) potency, (ii) price, and (iii) value of cannabis resin and herbal cannabis in Europe from 2006-2016.

Methods

Design

This repeated cross-sectional study was reported according to the "strengthening the reporting of observational studies in epidemiology" (STROBE) statement (36) and the revised checklist for writing research reports in Addiction (37).

Measures

Data were collected each year from 2006-2016 by the EMCDDA via its network of 30 national focal points across the 28 EU Member States, Norway and Turkey. Standardised reporting tools were used to harmonise data reporting across countries. For cannabis products, data were requested separately for (i) cannabis resin, (ii) herbal cannabis (unspecified herbal cannabis), (iii) herbal cannabis (sinsemilla), and (iv) other herbal cannabis (European or non-European seeded herbal cannabis). Data were collected for potency (laboratory test results for the concentration of THC to the nearest 0.1%) and price (at the retail level (≤100g) in Euros, converted from local currency using the exchange rate for the time period specified). Additional information on study methodology, sampling strategy and geographical coverage was requested where available, in line with an improved data collection regime for drug supply indicators (38, 39). Cannabis potency data were predominantly collected through analysis of police seizures at the national level (see Online Supporting Information, Table S1 for country-specific information). Price data were predominantly obtained by police surveys at the national level (see Online Supporting Information, Table S2 for country-specific information).

From 2006-2016, outcome measure data were extracted for cannabis potency (mean THC concentration, %) and price (mean Euro) at the retail level separately for each cannabis product (resin, herbal), year and country. All data meeting these criteria were included. Where countries provided data for both potency and price within a single year, a measure of value was calculated. For this measure we chose the quantity of THC per price unit (mg THC/Euro) as these data were normally distributed (skewness: mean z-score=0.71, p=0.475, kurtosis: mean z-score=0.02, p=0.981). Data from an alternative measure (Euros/mg THC) were not used due to strong evidence of positive skew (mean z-score=3.24, p=0.001) and platykurtosis (mean z-score=3.88, p<0.001). The number of countries providing eligible data for each year and category are shown in Table 1. Where two estimates were available from a single year and country (e.g. potency estimates from both sinsemilla and other herbal cannabis; price estimates from both drug users and police), both estimates were included in the statistical models.

For ease of interpretation, all *observed* price data shown in the text, tables and figures were presented as mean (+/- 95% CI) observed values unadjusted for inflation. For example, price data labelled as 2006 reflects the price in 2006 Euros; price data labelled as 2007 reflects the price in 2007 Euros, etc. In order to account for price inflation, Harmonised Indices of Consumer Prices data were obtained from Eurostat for the 28 EU Member States, Norway and Turkey. These data were used to calculate *expected* changes based on annual inflation from 2006. These expected data were presented alongside the observed (unadjusted) data in Figures to visually illustrate both of these trends. In order to adjust for inflation in statistical models, we calculated adjusted outcome variables in which the expected data (based on inflation) was subtracted from the observed (unadjusted) data. These data were used to

statistically test whether time trends persisted after adjusting for inflation, but are not presented in the text, tables and figures.

Statistical Analysis

Mixed effects linear regression models (STATA command: mixed) with maximum likelihood estimation were used to quantify changes in cannabis potency, price and value from 2006-2016. This approach was chosen to account for data structure (data were collected within countries) and for improved handling of missing data compared to general linear model approaches. Year (coded as 0-10 for years 2006-2016) was fitted as a fixed effect (linear trend) predicting the dependent variable of interest. Next, a quadratic trend of Year was added as a fixed effect. If the quadratic trend improved model fit it was retained in the model. Next, Country was included as a random intercept and slope using an independent covariance structure. In each of the analyses, adding Country improved model fit and was therefore retained in all models. Model fit was assessed by change in Bayesian Information Criterion (ΔBIC; 0-2=weak evidence, 2-6=positive evidence, 6-10=strong evidence, >10=very strong evidence) as recommended by Raftery (40) and/or a χ^2 likelihood ratio test ($p<0.05$). Further information on the model fitting process is provided in the Online Supporting Information. Parameter estimates are presented as unstandardised regression coefficients (b). All data presented in the text, tables and figures are from the final statistical models, in which 95% Confidence Intervals were estimated using robust methods (10,000 bootstrapping samples; bias-corrected and accelerated Confidence Intervals).

Results

(i) Changes in potency

Estimates of resin potency in Europe are shown in Figure 1(A) and Table 2. Resin potency increased from a mean (95% CI) of 8.14% THC (6.89, 9.49) in 2006 to 17.22% THC (15.23, 19.25) in 2016. There was evidence for a quadratic trend of Year (b=0.11, 95% CI: 0.06, 0.16, z=4.01, $p<0.001$). This quadratic trend reflected relatively stable THC concentrations from 2006-2011 (increases of <1% per year) followed by an increasing trend from 2011-2016. There was no evidence for a linear trend of Year. Country-specific parameter estimates are shown in the Online Supporting Information (Figure S1).

Estimates of herbal cannabis potency in Europe are shown in Figure 1(B) and Table 2. Herbal cannabis potency increased from 5.00% THC (3.91, 6.23) in 2006 to 10.22% THC (9.01, 11.47) in 2016. There was evidence for a linear trend of Year, reflecting an increase in potency over time (b=0.52, 95% CI: 0.43, 0.61, z=11.51, $p<0.001$). There was no evidence for a quadratic trend of year. Country-specific parameter estimates are shown in the Online Supporting Information (Figure S2).

(ii) Changes in price

Estimates of cannabis resin price in Europe are shown in Figure 1(C) and Table 3. Resin price increased from 8.21 (7.54, 8.97) Euros per gram in 2006 to 12.27 (10.62, 14.16) in 2016. There was evidence for a linear trend of Year, reflecting an increase in price over time (b=0.41, 95% CI: 0.23, 0.58, z=4.55, $p<0.001$). There was no evidence for a quadratic trend of Year. Country-specific parameter estimates are shown in the Online Supporting Information (Figure S3). This linear trend of Year persisted after adjusting for inflation

(b=0.23, 95% CI: 0.06, 0.40, z=2.59, *p*=0.010). There was no evidence for a quadratic trend of Year.

Estimates of herbal cannabis price in Europe are shown in Figure 1(D) and Table 3). Herbal price increased from 7.36 (6.22, 8.53) Euros per gram in 2006 to 12.22 (10.59, 14.03) in 2016. There was evidence for a linear trend of Year, reflecting an increase in price over time (b=0.49, 95% CI: 0.35, 0.62, z=6.99, *p*<0.001). There was no evidence for a quadratic trend of Year. Country-specific parameter estimates are shown in the Online Supporting Information (Figure S4). This linear trend of Year persisted after adjusting for inflation (b=0.32, 95% CI: 0.18, 0.46, z=4.60, *p*<0.001). There was no evidence for a quadratic trend of Year.

(iii) Changes in value

Estimates of value for cannabis resin are shown in Figure 1(E) and Table 4. The quantity of THC (mg) for every Euro spent increased from 11.00 (8.60, 13.62) in 2006 to 16.39 (13.68, 19.05) in 2016. There was evidence for a quadratic trend of Year (b=0.10, 95% CI: 0.03, 0.17, z=2.68, *p*=0.007) but not a linear trend of Year. This quadratic trend reflected relatively stable value for money from 2006-2011 (increases of <0.5 mg THC/Euro each year), followed by an increase in value from 2011-2016. Country-specific parameter estimates are shown in the Online Supporting Information (Figure S5). This quadratic trend of Year persisted after adjusting for inflation (b=0.08, 95% CI: 0.01, 0.15, z=2.25, *p*=0.025). There was no evidence for a linear trend of Year.

Estimates of value for herbal cannabis are shown in Figure 1(F) and Table 4. The quantity of THC (mg) for every Euro spent was similar in 2006 at 12.65 (10.18, 15.34) and in 2016 at 12.72 (10.73, 14.73). There was evidence for a linear trend of Year (b= -1.17, 95% CI: -1.97,

-0.36, z= -2.83, *p*=0.005) and a quadratic trend of Year (b=0.12, 95% CI: 0.05, 0.19, z=3.18, *p*<0.001). These trends reflected an initial decrease in value, followed by a return to the same level. Country-specific parameter estimates are shown in the Online Supporting Information (Figure S6). After adjusting for inflation, there was evidence for a quadratic trend of Year (b=0.10, 95% CI: 0.03, 0.17, z=2.66, *p*=0.008) but not a linear trend of Year (b= -0.75, 95% CI: -1.57, 0.06, z= -1.81, *p*=0.070).

Discussion

Here we report previously unpublished data from the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), quantifying changes in the potency, price and value of cannabis resin and herbal cannabis in Europe. We found clear evidence for increases in the potency of both cannabis products in Europe from 2006-2016. This rise was more substantial for cannabis resin than herbal cannabis. The price of cannabis resin and herbal cannabis also increased during this time, and these trends persisted after adjusting for inflation. Combined data on price and potency showed an increase in the value of cannabis resin but not herbal cannabis from 2006-2016.

A noteworthy finding of this study is the marked increase in the potency of cannabis resin from 2006-2016. This increase was characterised by a quadratic trend which was especially pronounced from 2011-2016, during which resin potency increased from approximately 10.0% THC to 17.2% THC. The time course of these changes is strikingly similar to those recently reported in France (23), with a marked increase starting from 2011. Although French data contributed to our estimates at the European level, our data show that high potency resin (often exceeding 20% THC) has penetrated European markets more widely, including regions of central Europe and Scandinavia. The replacement of traditional landrace "kif" cannabis

plants with new high-potency strains in Morocco provides a convincing explanation for these changes (21, 22). However, local (European) resin production using high-potency strains may have also contributed to the emergence of higher potency resin products in European drug markets (14).

The linear increases in herbal cannabis potency we report here are consistent with previous data collected worldwide (29). Studies in the United States (41) and France (23) have attributed increases in the potency of herbal cannabis to a rise in the availability of high-potency, indoor grown forms of herbal cannabis, often called sinsemilla or nederwiet. This offers one possible explanation for the increase in herbal cannabis potency observed in Europe. Another plausible reason is an increase in potency within the same type(s) of cannabis, which has previously been reported in the Netherlands (28). One strength of our reporting tool was its ability to capture data on multiple types of herbal cannabis. However, only three European countries (Netherlands, Sweden, Croatia) provided eligible data on two types of herbal cannabis, and for this reason we did not stratify our analysis by type of herbal cannabis. The estimates we obtained for herbal cannabis potency in Europe lie between previous estimates of high-potency indoor grown herbal cannabis and imported herbal cannabis (27, 42). They are also very similar to estimates of all forms of herbal cannabis from the United States during the same time period, when the proportion of sinsemilla samples increased (41). This suggests that increases in the market share of high-potency, indoor grown forms of cannabis may be the most likely explanation for the linear trends in herbal cannabis potency we observed in Europe. They also highlight that this increase is an international phenomenon that is unlikely to be attributable to local (European) factors alone.

The increase in potency of European cannabis resin and herbal cannabis could potentially result in these products carrying greater health risks. THC has been positively associated with harms in several studies using a range of experimental and observational research methods (2-6, 10). Rising THC in cannabis may have contributed to the marked increase in treatment for cannabis disorders (11) that has been evident across Europe and now accounts for more first-time admissions to specialist treatment than any other illicit drug (43). Although THC is the primary cannabis constituent responsible for its harmful effects, CBD may offset some of these harms (15-17). For example, some (but not all (44)) studies have reported that the acute effects of THC on verbal memory impairment (45, 46) and psychotic-like symptoms (46, 47) were partially offset when CBD was co-administered with THC.

An important limitation of the current study is that data on CBD were not collected. Analyses of cannabis resin seizures in both France and Denmark indicated that CBD concentrations remained stable from 2006-2016 (~4% in France (23) and ~6% in Denmark (48)) while THC increased markedly, following the same trend and time course as we report here across Europe. On the basis of these data, it might be expected that CBD concentrations also remained relatively stable across Europe from 2006-2016, although further evidence would be needed to support or refute this. As a result of rising THC and stable CBD in France and Denmark, THC:CBD ratios rose in both countries (23, 48). Information on CBD and the THC:CBD ratio may provide important additional information on the harmful effects of cannabis, in addition to THC alone. However, while several studies have shown dose-dependent effects of THC in humans (with higher doses causing greater harm (10)), none have tested the effects of multiple THC:CBD ratios (15). Therefore, the relationship between THC:CBD ratio and level of harm is currently unclear, and THC concentrations should be

taken as the single most important "primary outcome" in studies of cannabis potency at present.

Cannabis price increased from 2006-2016, and these trends persisted after adjusting for inflation in consumer prices. These data offer a sharp contrast to those observed in Washington State, where prices have continued to drop since the advent of legal sales (31, 32). Experimental studies suggest that both price and potency may influence purchasing behaviour and consumption (33-35). As a result, combining information on price and potency may be informative. We found that for herbal cannabis, value for money (quantity of THC per Euro spent) showed an initial decrease followed by a return to similar levels. This suggests that the value for money of herbal cannabis was comparable in 2006 (~12.7mg THC per Euro) and 2016 (~12.7mg THC per Euro). By contrast, the value of cannabis resin remained stable from 2006 (~11.0mg THC per Euro) to 2011 (~11.2mg THC per Euro) but then rose to ~16.4mg THC per Euro in 2016. It has been argued (22) that new resin production methods emerged in Morocco to compete with the domestic European market, including locally grown herbal cannabis. Our data support this argument by showing that cannabis resin increased in its relative value compared to herbal cannabis, potentially making it more attractive to consumers. It may be the case that new resin production methods in Morocco and elsewhere (e.g. using higher potency cannabis plants) are more economically efficient, and these savings can be passed on to European consumers.

This study has several strengths. It includes previously unpublished data on illicit drug markets that are largely hidden from scientific investigation. These data include recent European and country-specific level estimates covering 11 years, providing internationally relevant information for policy and practice. Moreover, it includes separate estimates for

different cannabis products, which are very rarely distinguished from each other in research studies at present (49). However, this study also has some limitations. Firstly, the use of police seizures for obtaining cannabis products and police surveys for estimating price may result in sampling bias when estimating drug use at the retail level. However, this is a limitation common to almost all monitoring data on drug markets (apart from in the Netherlands (27)). As data on retail prices included transactions ≤100g, they may have underestimated the price of cannabis at lower ends of the retail market. However we have no reason to believe that sampling bias or size of retail transaction varied systematically by time and therefore it is unlikely that these contributed to the trends reported here. Secondly, we were unable to verify data collection methods across countries. However, data collection tools were harmonised using standardised tools to collect the most accurate, reliable, comparable and high-quality data on European drug markets available. Thirdly, annual data for each cannabis product were not consistently available for each of the 28 European Member States, Norway and Turkey. However, the mixed effects modelling approach we used improves handling of missing data by making use of all available data without listwise deletion. Additionally, the inclusion of country as a random intercept and slope can increase the extent to which results are generalisable to other countries that were not sampled (50). Furthermore, we used bootstrapping to generate robust confidence intervals that are not constrained by sampling distribution assumptions. A final limitation is the absence of data on CBD.

In conclusion, this study provides evidence for increases in the potency and price of cannabis resin and herbal cannabis in Europe from 2006-2016. Cannabis resin showed a larger increase in potency when compared to herbal cannabis. It also increased in relative value, resulting in a higher quantity of THC for each Euro spent on cannabis. These data provide important new

information on international drug markets at a time of rapid change in global cannabis policy and cannabis products.

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Table 1: European coverage of cannabis potency, price and value data. Data show the number of European countries providing eligible data each within each category and year (Countries) and the median sample size for each estimate of potency or price (Sample).

	Resin potency		Herbal potency		Resin price		Herbal price		Resin value	Herbal value
	Countries	Sample	Countries	Sample	Countries	Sample	Countries	Sample	Countries	Countries
2006	15	30	15	58	13	47	13	50	9	12
2007	13	32	16	81	12	46	14	45	7	10
2008	18	35	19	100	15	56	15	58	10	14
2009	18	75	20	119	15	47	14	83	12	13
2010	19	43	21	207	15	36	15	54	12	14
2011	19	57	21	254	14	31	14	48	12	14
2012	18	38	20	249	17	46	16	39	13	16
2013	18	40	20	320	15	31	17	61	13	16
2014	17	36	20	357	14	41	17	66	10	15
2015	16	42	20	342	15	46	17	67	10	14
2016	15	42	19	329	19	43	19	65	12	15

Table 2: Potency of cannabis resin and herbal cannabis in Europe, 2006-2016. Data show mean (95% CI) concentrations of THC (%)

	Cannabis resin			**Herbal cannabis**		
	Mean	(95% CI)		Mean	(95% CI)	
2006	8.14	(6.89,	9.49)	5.00	(3.91,	6.23)
2007	8.08	(6.95,	9.25)	5.52	(4.38,	6.80)
2008	8.23	(6.98,	9.51)	6.05	(4.95,	7.30)
2009	8.60	(7.28,	9.95)	6.57	(5.58,	7.65)
2010	9.18	(7.96,	10.49)	7.09	(6.03,	8.24)
2011	9.98	(8.67,	11.31)	7.61	(6.56,	8.74)
2012	11.00	(9.52,	12.53)	8.13	(7.07,	9.23)
2013	12.23	(10.59,	13.92)	8.66	(7.65,	9.68)
2014	13.68	(11.96,	15.44)	9.18	(7.93,	10.43)
2015	15.34	(13.45,	17.40)	9.70	(8.43,	11.01)
2016	17.22	(15.23,	19.25)	10.22	(9.01,	11.47)

Table 3: Price of cannabis resin and herbal cannabis in Europe, 2006-2016. Data show mean (95% CI) Euros per gram of cannabis

	Cannabis resin			**Herbal cannabis**		
	Mean	(95% CI)		Mean	(95% CI)	
2006	8.21	(7.54,	8.97)	7.36	(6.22,	8.53)
2007	8.61	(7.86,	9.44)	7.85	(6.64,	9.09)
2008	9.02	(8.21,	9.89)	8.33	(7.09,	9.65)
2009	9.43	(8.54,	10.41)	8.82	(7.55,	10.17)
2010	9.83	(8.87,	10.88)	9.30	(8.10,	10.60)
2011	10.24	(9.23,	11.34)	9.79	(8.48,	11.14)
2012	10.64	(9.52,	11.87)	10.28	(8.76,	11.91)
2013	11.05	(9.80,	12.45)	10.76	(9.30,	12.31)
2014	11.45	(10.21,	12.80)	11.25	(9.58,	13.03)
2015	11.86	(10.48,	13.41)	11.73	(9.98,	13.65)
2016	12.27	(10.62,	14.16)	12.22	(10.59,	14.03)

Table 4: Value of cannabis resin and herbal cannabis in Europe, 2006-2016. Data show mean (95% CI) mg of THC for each Euro spent

	Cannabis resin			**Herbal cannabis**		
	Mean	(95% CI)		Mean	(95% CI)	
2006	11.00	(8.60,	13.62)	12.65	(10.18,	15.34)
2007	10.65	(8.40,	13.15)	11.60	(9.44,	13.91)
2008	10.50	(8.17,	13.17)	10.79	(8.69,	13.10)
2009	10.55	(7.92,	13.46)	10.21	(8.35,	12.15)
2010	10.80	(8.11,	13.80)	9.86	(7.72,	12.18)
2011	11.24	(8.39,	14.41)	9.75	(7.60,	12.19)
2012	11.87	(9.29,	14.79)	9.87	(7.80,	12.08)
2013	12.71	(10.04,	15.64)	10.23	(8.21,	12.44)
2014	13.74	(10.72,	16.94)	10.83	(8.80,	12.97)
2015	14.96	(12.39,	17.64)	11.65	(9.77,	13.54)
2016	16.39	(13.68,	19.05)	12.72	(10.73,	14.73)

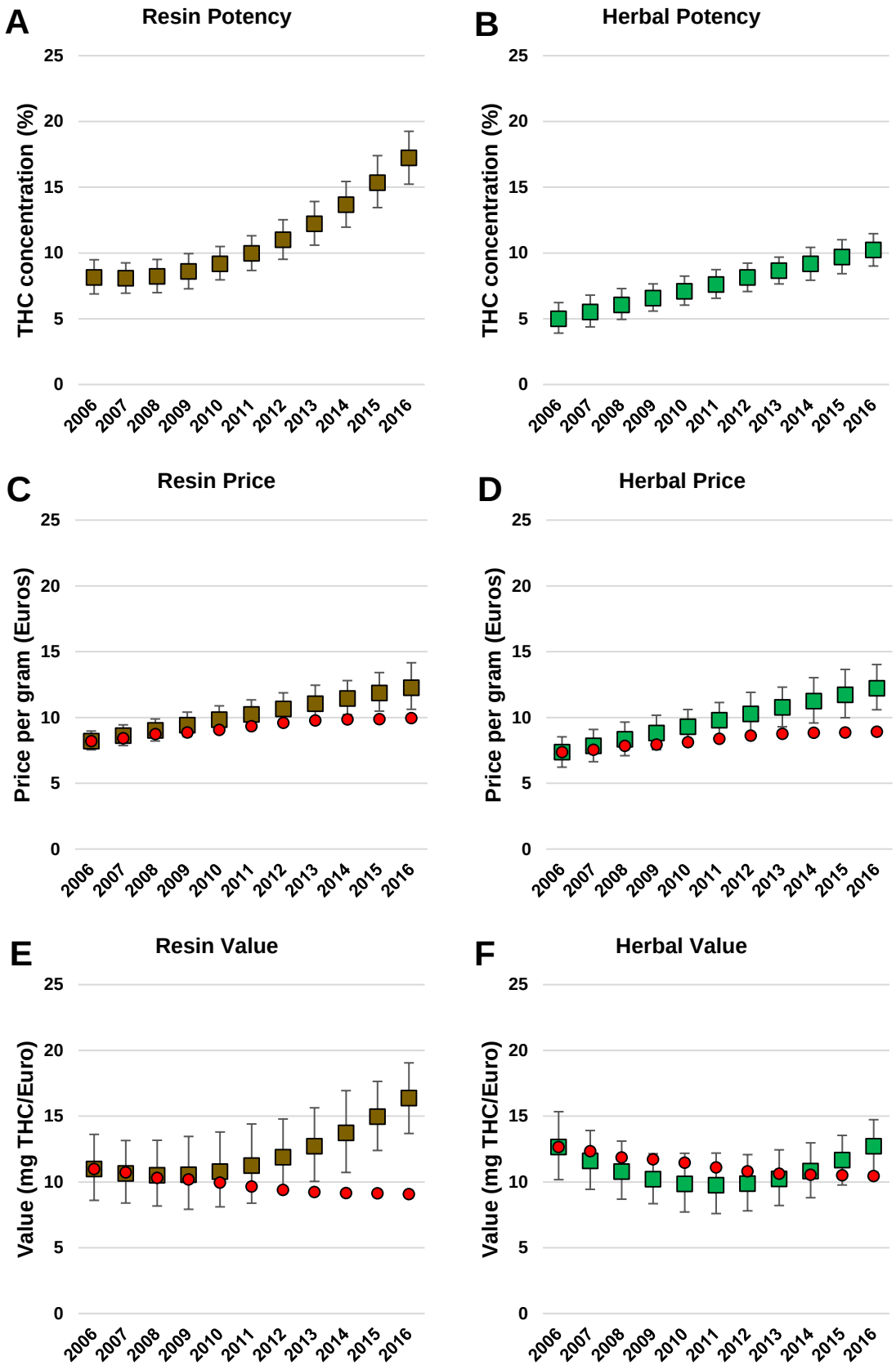

Figure 1. Changes in cannabis potency, price and value in Europe by year, 2006-2016. Data shown are mean (+/- 95% CIs) observed values and are unadjusted for inflation. Red circles show expected price changes based on inflation alone. (A) Potency of cannabis resin, (B) Potency of herbal cannabis, (C) Price per gram of cannabis resin, (D) Price per gram of herbal cannabis, (E) Value of cannabis resin, (F) Value of herbal cannabis.