

# Retrospective survey of the patterns of prescription and request for vitamins, minerals and vitamin-mineral formulations for dogs in a veterinary hospital in Nigeria

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## *Abstract*

This study evaluated the patterns of prescription/request of vitamins, minerals and vitamin-mineral formulations (V-MF) for dogs presented for veterinary care at the Veterinary Teaching Hospital Nsukka (VTHN), Nigeria, between January 2013 and December 2017. Hospital records of a total of 4074 dogs were used for the study. Overall, vitamins, minerals and V-MF were prescribed/requested for 3096 out of the 4074 cases (75.33%). The frequency of prescription/requests for vitamins, minerals and V-MF significantly ( $p=0.000$ ) increased from 54.1% in 2013 to 87.8% (highest) recorded in 2016 and the effect size of the variations across time was very strong ( $\phi_c=0.268$ ). Vitamin B-Complex injections were the most frequently prescribed/requested (2212/3096), followed by multivitamin injections (745/3096), tablets + other oral V-MF (613/3096) and iron dextran (434/3096). The least prescribed/requested were vitamin K (32/3096) and calcium gluconate (73/3096). There were significant variations ( $p=0.000$ ) across the years of study in the frequency of prescription/requests for Vitamin B-complex injection, multivitamin injections and tablets + other oral V-MF but there were no significant variations ( $p>0.05$ ) in the frequency of prescription/requests for calcium gluconate, iron dextran and vitamin K. Overall, vitamins, minerals and V-MF were inappropriately prescribed in 6.43% of cases and wrongly combined in 12.21% of cases. The frequency of both inappropriate prescription and wrong combinations significantly ( $p=0.000$ ) varied across the study period. It was concluded that the frequency of prescription/requests for vitamins, minerals and VM-F for dogs in the hospital studied during the study period was high and significantly increased across the study period.

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**Keywords:** Vitamins and Minerals, Prescription/Request patterns, Dogs, Retrospective survey, Veterinary Hospital

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## Introduction

Vitamins and minerals are compounds that are present in minute quantities in food/feedstuff and are required in trace amounts to maintain normal body metabolism, health, growth and reproduction (McDowell, 2000; Murphy *et al.*, 2007). Vitamin-mineral formulations (V-MF) commonly contain two or more vitamins with or without minerals (Murphy *et al.*, 2007; Menon *et al.*, 2008). Supplemental vitamins, minerals and V-MF are readily available and are sold for use by both humans and animals, with estimated global annual sales of over 100 billion USD (Elango *et al.*, 2015; Mikulic, 2018; Hannon *et al.*, 2020). Despite the lack of firm evidence that the use of such supplemental vitamins, minerals and V-MF significantly contributes to the well-being of apparently healthy humans and animals, their use remains popular (Starr, 2015; Hannon *et al.*, 2020).

Several studies have shown the beneficial effects of the supplemental intake of vitamins, minerals and V-MF that exceed the recommended dietary allowance, while other studies have demonstrated the adverse effects of very high intakes of specific vitamins and minerals (Scaumburg *et al.*, 1983; Hathcock, 1997; McDowell, 2000; Mullholland and Benford, 2007; Menon *et al.*, 2008; Marosz and Chlubek, 2014; Roop, 2018). There are several reports in the available literature on the patterns of prescription, requests for and use and misuse of vitamins, minerals and V-MF by humans but there is a paucity of information in the available literature on the patterns of prescription and requests for supplemental vitamins, minerals and V-MF in animals generally, and in dogs specifically. The present study evaluated the patterns of prescription and requests for vitamins, minerals and VM-F in dogs presented for veterinary care at the Veterinary Teaching Hospital Nsukka from January 2013 to December 2017.

## Materials and Methods

The study was a five-year retrospective survey of hospital records of dogs presented for veterinary care between January 01, 2013 and December 31, 2017 at the Veterinary Teaching Hospital Nsukka (VTHN), Nigeria. The VTHN provides veterinary clinical and referral services to animals in Nsukka and communities/towns in the adjoining Eastern and Middle Belt states of Nigeria. Hospital records of all dogs presented to the hospital within the stated study period were used for the survey. Necessary approval was sought and received from the Director of the VTHN before the hospital records were used for the survey. Clients/animal owners, by default, consented to the records of their animals presented for veterinary care being used for 'studies that will benefit animal health and humanity' at registration for all clinical services in the hospital. Specific information/data about the clients/animal owners was kept confidential, by the use of number codes.

Hospital records of a total of 4074 dog case presentations across the five-year study period were used for the study. For each case presentation, data collected included the primary complaint, the case diagnosis (tentative or definitive), whether or not

vitamins, minerals and/or V-MF were prescribed or requested and the patterns of prescription/requests for the vitamins, minerals and V-MF.

Data obtained were collated year by year for the years 2013, 2014, 2015, 2016 and 2017, and subjected to descriptive statistics. The annual frequency of prescription/requests for each of the vitamins, minerals or V-MF was compared for each of the years and for the five year study period. Chi square or Fisher's exact test (where appropriate) was used to compare the annual frequencies of use of the specific vitamins, minerals and V-MF and the effect size of the variations in frequencies was determined by computing the Cramer's V (Fritz *et al.*, 2012; Akoglu, 2018). The annual frequencies of the different categories of irrational prescription/requests for vitamins, minerals and V-MF recorded in the study were also subjected to Chi square or Fisher's exact test and the effect size computed as stated above. Version 16.0 of the statistical package for social sciences (SPSS) software was used for all the statistical analysis and results were presented in summary tables and bar charts.

## Results and Discussion

The total of 4074 dog case presentations used for the study comprised 604 cases in 2013, 646 in 2014, 877 in 2015, 935 in 2016, and 1012 in 2017 (Table 1). The steady rise across the five-year study period in the number of dogs presented for veterinary care at the VTHN is worthy of note. It is thought that this may not really be a reflection of the increase in the population of dogs in the study area, rather it may be more due to an increase in the number of dog owners who patronize orthodox veterinary clinical services. There is greater awareness of the value of orthodox veterinary clinical services for dogs, which is believed to be connected to the free anti-rabies vaccination and enlightenment programmes that were instituted in the hospital between 2014 and 2017 - this brought dog owners to an awareness and consciousness of the value of veterinary clinical services.

Out of the total 4074 cases, vitamins, minerals and V-MF were prescribed or requested for in 3096 cases (75.33%) [Table 1]. The annual frequency of prescription or requests for vitamins, minerals and V-MF during the study period ranged from a minimum of 54.1% (327 out of 604 cases) recorded for the year 2013 to a maximum (87.8%) recorded in the year 2016 (821 out of 935 case presentations) [Table 1]. There was a significant ( $p = 0.000$ ) increase in the frequency of prescription/requests for vitamins, minerals and V-MF across the five year study period and the effect size ( $\phi_c=0.268$ ) of the annual variations in frequency was very strong (Table 1). This 75.33% frequency of case presentations in which vitamins, minerals and/or V-MF were prescribed or requested in the present study is considered high. It is close to and comparable to the 73.1% reported by Eze and Olowu (2011) for humans at the Olabisi Onabanjo University Teaching Hospital, Sagamu Nigeria, and the 74.85% reported by Osarenmwinda and Erah (2015) at a human tertiary health facility in Benin City Nigeria. It is, however, higher than the 41% reported for American human

adults in a 2006 study (SEC, 2006), the 62.9% reported by Akande and Ologe (2007) for a human health facility in Ilorin Nigeria and the 35% reported for selected human primary health facilities in Ibadan Nigeria by Adisa *et al.*, (2015). It is thought that the overall height and significantly increased frequency of prescription/requests for vitamins, minerals and V-MF across the study period is related and in trend with

the increase in social marketing strategies of the producers and marketers of vitamins, minerals and V-MF, who commonly declare mouth-watering benefits from their use. The colourful labelling and advertisements of the vitamins, minerals and V-MF usually lead clients to request for them irrespective of whether they really are of any benefit or not (Mikulic, 2018; Hannon *et al.*, 2020).

**Table 1** The percentage frequency of prescription/request of vitamins, minerals and vitamin-mineral formulations (V-MF) for dogs presented for veterinary care at the hospital during the study period (2013 – 2017).

Study period (year)	Total number of dogs presented for veterinary care in the hospital.	Number of dogs for which vitamins, minerals or V-MF were prescribed or requested	Percentage frequency of dogs for which vitamins, minerals or V-MF were prescribed or requested.
2013	604	327	54.1%
2014	646	448	69.3%
2015	877	619	70.6%
2016	935	821	87.8%
2017	1012	854	84.4%
<b>Total for the five-year study period.</b>	<b>4074</b>	<b>3096</b>	<b>75.33 %</b>

There were significant ( $p = 0.000$ ) variations in the frequency of prescription/request of vitamins, minerals and V-MF for dogs across the study period (2013 – 2017), and the effect size of the variations was very strong ( $\phi_c = 0.268$ ); [ $\chi^2 = 292.04$ ;  $df = 4$ ].

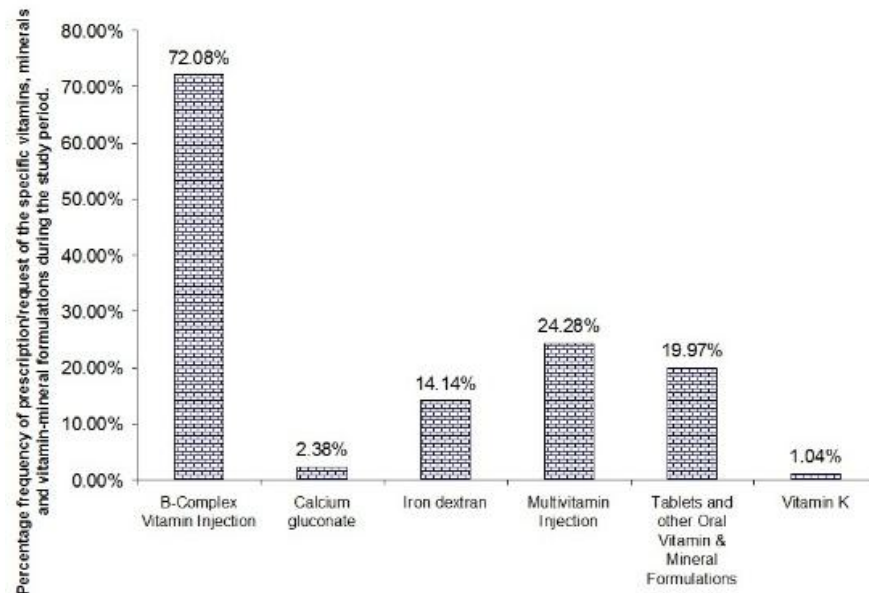
Vitamin B-Complex injection was the most frequently prescribed of the six categories of vitamins, minerals and V-MF, with a record overall frequency of 2212 out of the 3069 cases (72.08%) in which vitamins, minerals and V-MF were prescribed (Figure 1, Table 2). Vitamin B-Complex injection contains thiamine hydrochloride (vitamin B<sub>1</sub>), riboflavin 5-phosphate (vitamin B<sub>2</sub>), niacinamide (vitamin B<sub>3</sub>), dexpantenol (vitamin B<sub>5</sub>) and pyridoxine hydrochloride (vitamin B<sub>6</sub>). The fact that Vitamin B-Complex injection was the most frequently prescribed may be associated with its relative low cost, constant availability and the supposed expected benefits from its use. The findings in this present study that Vitamin B-Complex injection was the most frequently prescribed concurs with the reports of Adisa *et al.* (2015), on vitamins used in selected human health facilities in Ibadan Nigeria, in which Vitamin B-Complex injection topped the list as the most frequently used vitamin/supplement. Multivitamin injections followed Vitamin B-complex injections in frequency, with a record overall frequency of 745 out of the 3069 case presentations (24.28%) in which vitamins, minerals and V-MF were prescribed/requested (Figure 1, Table 2). The declared constituents of multivitamin injection for animals are vitamins A, D<sub>3</sub>, E, B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>6</sub>, B<sub>12</sub>, C and D-panthenol. The overall frequency of prescription/requests for tablets and oral V-MF was 19.97% (613 out of 3069 cases), while that of iron dextran followed with an overall frequency of 14.14% (434 out of the 3096 cases) [Figure 1, Table 2]. The declared composition of most of the tablets and oral V-MF included antioxidants, calcium, potassium, zinc, iodine, phosphorus, vitamins A, D<sub>3</sub>, E, B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>6</sub>, B<sub>12</sub> and C, iron, magnesium, copper, manganese and chloride, while that of iron dextran is ferric hydroxide and dextran. The least prescribed of the vitamins, minerals and V-MF were vitamin K (32 out of the 3096 cases = 1.04%) and calcium gluconate (73 out of the 3096 cases = 2.38%) [Figure 1, Table 2]. Vitamin K formulation contains phytonadione (vitamin K<sub>1</sub>) while calcium gluconate formulation contains mainly calcium. The relatively

lower frequency of prescription of Vitamin K and calcium gluconate may be as a result of the specificity of their use and clinical application (Reid *et al.*, 2015; Papich, 2016; Simes *et al.*, 2020), in contrast to Vitamin B-Complex injection, multivitamin injection and tablets & oral V-MF which are generally used to handle several deficiency disorders/diseases and in resuscitating recuperating patients (EFSA, 2006; Rock-Cheryl, 2007; Menon *et al.*, 2008). Earlier reports by Adisa *et al.* (2015), also showed that calcium gluconate was the second least frequently prescribed vitamin/mineral in selected health facilities in Ibadan Nigeria, as was also found in this present study.

The annual frequency of prescription/requests for Vitamin B-Complex injection, multivitamin injection and tablets & oral V-MF significantly ( $p = 0.000$ ) varied across the study period and the effect size of the variations was strong for the three (Table 2). Specifically, the annual frequency of prescription/requests for Vitamin B-complex injection ranged from a minimum of 56% in 2013 to a maximum of 86.6% in 2015 and later dropped to 63% in 2017, while that of prescription/requests for multivitamin injection was high in 2013 (49.2%) and subsequently dropped to its lowest value of 18.4% in 2015 (Table 2). The annual frequency of prescription/requests for tablets and oral V-MF increased steadily from its initial 8.0% in 2013 to its highest annual frequency of 29.5% in 2017 (Table 2). The increase across the five-year study period in the frequency of prescriptions for Vitamin B-Complex injection and tablets & other oral multivitamin formulations is believed to be due to the earlier stated increased awareness, intense advertisement and marketing strategies of the producers and marketers of these products; it is thought that it may not be as a result of higher occurrences of deficiency disorders/diseases in the study population. This increase in frequency across the five-year study period is a cause for concern because most of these micronutrients are obtainable from food/feedstuffs and additional administration of high doses may lead to adverse reactions, especially with

some of the micronutrients (Hathcock, 1997; Menon *et al.*, 2008; Marosz and Chlubek, 2014; Roop, 2018). This is much more to be worried about when one also considers that the increased frequency of overall prescriptions/requests also goes hand in hand with an increase in frequency of prescriptions of wrong combinations of these formulations such that a dog that is apparently healthy may be receiving multiple high doses of these micronutrients which may lead to toxicity (Elango *et al.*, 2015; Roop, 2018). Specifically, overdose of pyridoxine (vitamin B<sub>6</sub>), which is one of the constituents of the Vitamin B Complex injection, Multivitamin injection and oral multivitamin formulations, have been reported to lead to

neurological disturbances and sensory neuropathy (Schaumburg *et al.*, 1983), while the side effects of an excessive intake of niacin (vitamin B<sub>3</sub>), which is also a consistent component of both Vitamin B Complex injection, Multivitamin injection and oral multivitamin tablet formulations, has been reported to include hepatic toxicity and severe gastrointestinal disturbances (Rader *et al.*, 1992). Also, higher intakes of vitamin A, which is a common constituent of multivitamin injections and oral multivitamin formulations, have been associated with an increase in intracranial pressure, headache, adverse skin reactions, gastrointestinal disturbances and hepatosplenomegaly (Hathcock *et al.*, 1990).



**Figure 1** The percentage frequency of prescription/requests for the specific vitamins, minerals and vitamin-mineral formulations in dogs presented for veterinary care at the hospital during the five-year study period (2013 – 2017).

**Table 2** The pattern of prescription/request of specific vitamins, minerals and vitamin-mineral formulations (V-MF) in dogs presented at the veterinary hospital across the five year study period.

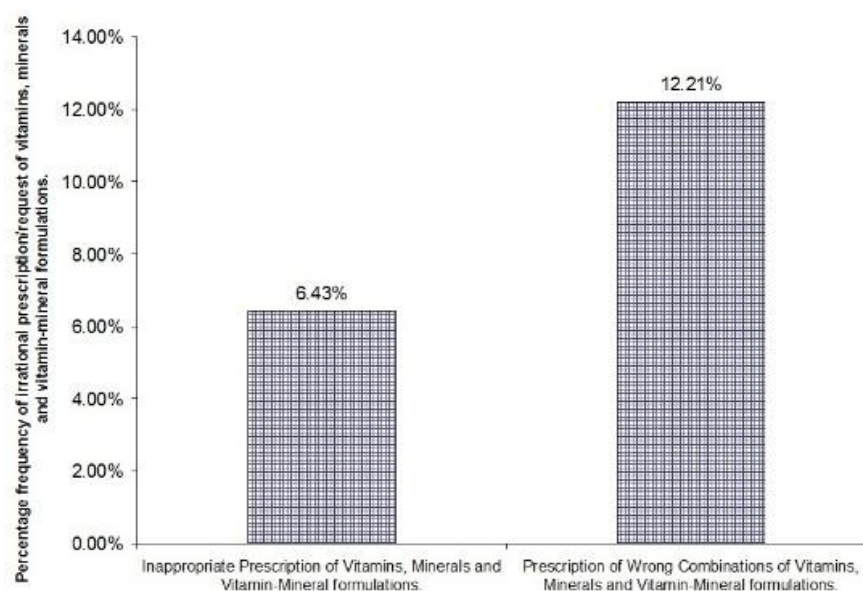
Specific vitamins, minerals and V-MF	No. of cases in which specified vitamins, minerals and V-MF were prescribed/requested for dogs across the five-year study period, with percentages in brackets.						Statistics			
	2013	2014	2015	2016	2017	Totals	$\chi^2$	df	p	$\phi_c$
<i>Vitamin B-Complex Injection</i>	183 (56.0%)	312 (69.6%)	499 (86.6%)	680 (82.8%)	538 (63.0%)	2212	148.03	4	0.000	0.220
<i>Calcium gluconate</i>	7 (2.1%)	12 (2.7%)	14 (2.3%)	21 (2.6%)	19 (2.2%)	73	0.49	4	0.974	0.013
<i>Iron dextran</i>	50 (15.3%)	59 (13.2%)	79 (12.8%)	111 (13.5%)	135 (15.8%)	434	3.89	4	0.421	0.036
<i>Multivitamin Injection</i>	161 (49.2%)	112 (25.0%)	114 (18.4%)	162 (19.7%)	196 (23.0%)	745	132.55	4	0.000	0.208
<i>Tablets and other Oral V-MF</i>	26 (8.0%)	39 (8.7%)	124 (20.0%)	172 (21.0%)	252 (29.5%)	613	114.22	4	0.000	0.193
<i>Vitamin K</i>	4 (1.2%)	5 (1.1%)	7 (1.1%)	7 (0.9%)	9 (1.1%)	32	0.73	4	0.961	0.012
<b>Totals</b>	327	448	619	821	854	3069				

$\chi^2$  – Pearson Chi-square or Exact test; df – degree of freedom; p – significance level;  $\phi_c$  – Cramer's V.

There were, however, no significant ( $p > 0.05$ ) variations across the study period in the annual frequency of prescription/requests for calcium gluconate, iron dextran and vitamin K, with the effect size of their variation being very weak (Table 2). Specifically, the annual frequency of prescriptions for calcium gluconate ranged from 2.1% to 2.7% during the study period, while that of iron dextran ranged from 12.8% to 15.8% and that of vitamin K ranged from 0.9% to 1.2% (Table 2). The lack of significant variations in the frequency of prescriptions for calcium gluconate, iron dextran and Vitamin K across the study period is thought to be as a result of the earlier stated strict specificity of their clinical use and application (Reid *et al.*, 2015; Papich, 2016; Simes *et al.*, 2020), in comparison with the others such as Vitamin B-Complex injection, multivitamin injection and tablets & oral V-MF which are routinely used to handle several deficiency diseases/disorders and overall patient recuperation (EFSA, 2006; Rock-Cheryl, 2007; Menon *et al.*, 2008).

The two categories of irrational prescription/requests for vitamins, minerals and V-MF recorded in the study were inappropriate prescriptions and prescriptions of wrong combinations (Figure 2). Inappropriate prescription was recorded in

cases where vitamins, minerals and V-MF were prescribed for apparently healthy dogs (with no complaints) that were presented for routine check-up or for vaccination, while wrong combinations were recorded in cases where, for instance, multivitamin injections were co-administered with Vitamin B-complex or tablets and oral V-MF which contain the same vitamins and minerals in as high a dose as is declared to be in the other. Overall, inappropriate prescription of vitamins, minerals and V-MF was recorded in 199 out of 3096 cases (6.43%), while prescription of wrong combinations was recorded in 378 out of 3096 cases (12.21%) [Figure 2, Table 3]. The inappropriate prescription of vitamins, minerals and V-MF for apparently healthy dogs and the use of wrong combinations that deliver multiple high doses of some vitamins, minerals or V-MF is a cause for concern and not in line with the national policy on rational use of medicines (FMHN, 2010), as animal owners may be purchasing/paying extra for adverse reactions and toxic effects that may arise from overdose (Schaumburg *et al.*, 1983; Rader *et al.*, 1992; Hathcock, 1997; Mullholland and Benford, 2007; Menon *et al.*, 2008; Roop, 2018).



**Figure 2** The overall percentage frequency of the various categories of irrational prescription/requests (inappropriate prescription and wrong combinations) for vitamins, minerals and vitamin-mineral formulations in dogs presented for veterinary care at the hospital during the five-year (2013 – 2017) study period.

**Table 3** The patterns of irrational prescription/requests of vitamins, minerals and vitamin-mineral formulations (V-MF) for dogs presented for veterinary care at the veterinary hospital during the five-year study period (2013 – 2017).

Specific categories of irrational prescription/request of vitamins, minerals and V-MF	No. of cases in which specified category of irrational prescription/request of vitamins, minerals and V-MF was recorded across the five-year study period, with percentages in brackets.						Statistics			
	2013	2014	2015	2016	2017	Totals	$\chi^2$	df	p	$\phi_c$
<i>Inappropriate prescription</i>	5 (1.5%)	12 (2.7%)	34 (5.5%)	96 (11.7%)	52 (6.1%)	199	61.90	4	0.000	0.142
<i>Prescription of wrong combinations</i>	13 (4.0%)	20 (4.5%)	51 (8.2%)	154 (18.8%)	140 (16.4%)	378	100.85	4	0.000	0.181
<b>Totals</b>	327	448	619	821	854	3069				

$\chi^2$  – Pearson Chi-square; df – degree of freedom; p – significance level;  $\phi_c$  – Cramer's V.

The annual frequency of inappropriate prescriptions of vitamins, minerals and V-MF rose from 1.5% in 2013 to its highest frequency of 11.7% in 2016 and afterwards dropped to 6.1% in 2017 (Table 3). The annual frequencies of inappropriate prescription varied significantly ( $p = 0.000$ ) across the five-year study period and the effect size of the variations in frequency ( $\phi_c=0.142$ ) was moderate (Table 3). There were also significant ( $p = 0.000$ ) variations in the annual frequency of prescription of wrong combinations of vitamins, minerals and V-MF, with a strong effect size ( $\phi_c=0.181$ ) [Table 3]. The increases recorded across the study period in the frequency of these categories of irrational prescription/requests is comparable to the reports in the literature of increases across the same study period and in the same hospital in the inappropriate use and wrong combinations of antibiotics (Ihedioha *et al.*, 2020) and anti-parasitic agents (Ihedioha *et al.*, 2021). These consistent reports of irrational prescriptions/misuse of medicines in animals is worthy of concern and further makes it a point of duty for veterinary clinicians, other animal health workers and trainees to become mindful and aware of the possible dangers associated with both inappropriate prescriptions and prescription/requests of wrong combinations of vitamins, minerals and V-MF specifically and drugs in general (Gautam and Aditya, 2006), as recommended in the national policy on rational use of medicines (FMHN, 2010).

Based on the results of the study, it was concluded that the frequency of prescription/requests for vitamins, minerals and V-MF recorded during the five-year study period (2013 – 2017) was high (75.33%) and that there was a significant increase across the study period in the overall frequency of prescription/requests for vitamins, minerals and V-MF, their inappropriate prescription/requests and prescription of wrong combinations. Vitamin B-Complex injection was the most frequently prescribed. Sensitization and enlightenment of veterinary clinicians, other animal health workers and trainees on the possible adverse consequences of irrational prescriptions/requests for vitamins, minerals and V-MF is advocated.

**Statement of Animal Rights:** Animals were not used directly in the study. Only the medical records of animals presented for veterinary care at the hospital were used in the study. The use of these medical records was approved by the Director of the Veterinary Hospital.

**Conflict of Interest:** The authors declare no conflict of interest.

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